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Track buckled by flow of ice underneath

Washout at a small stream crossing

The Difficulties of Railroad Maintenance in Alaska

By Kirk McFarlin

RAILROAD construction in the United States to-day is of so thorough a nature, and operation is so systematic, that the service is seldom interrupted. Spring floods and heavy winter storms sometimes excuse a delay in traffic, but as a rule the maintaining of schedules as well as of road-beds has become a matter of routine. In Alaska, however, the frontier of to-day, railway operation is more difficult than it was a quarter of a century ago in the states at home. The wild nature of the country, the severity of the climate, and the occurrence of natural phenomena not found elsewhere make construction as well as timetables very uncertain. The Copper River and Northwestern R. R., the longest of the two standard gage lines now in operation in Alaska, probably combats natural conditions more severe and peculiar than those encountered by any other railroad in the world.

The Copper River and Northwestern connects the now well-known Kennecott copper mines with the seaboard. Two hundred miles of single track line were built in the years 1908-11 at a cost of $16,000,000, an average of $80,000 per mile. The seaboard terminus, Cordova, is 1,500 miles northwest of Seattle. The line first pierces, through a very rugged gorge, the almost unbroken mountain barrier which skirts the Alaskan coastline, then penetrates to the center of the higher interior mountains. A steady rise, with limiting grades of five per cent, brings the line to a final elevation of 4,000 feet.

Copper river bridge, Childs glacier in distance

The first 40 miles of rail traverse the broad delta of the Copper River, which is broken by hundreds of small glacial channels. The mountains are then reached, and for the next hundred miles the line threads the gorge of the Copper River. This river, so-called from the large nuggets of native copper found along its course, has cut, through the mountains which rise above to heights of 8,000 and 10,000 feet, a box-like canyon of varying width, with a flat floor of gravel, and sides perfectly sheer. At intervals along its length large glaciers projecting from the ice fields on either side spread out over the floor of the canyon, and shifting glacial streams intercept the river. The lower entrance to the canyon is flanked by the two largest glaciers, with frontal widths of 3 and 5 miles, one on either side of the river. Their ice faces, towering 300 feet above the river, form one of the sights of all Alaska. The Copper River bridge, which spans the river between these glaciers, ranks among our remarkable bridges. Its three long truss spans were built in a single winter, despite arctic cold and blinding storms. Falsework and caissons were driven through 12 feet of ice, the movement of which at one time carried the last span 12 inches out of line. The final span was joined up but

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At Baird canyon; rails overturned by whirlpool

One of the obstructions encountered

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

A National Calamity

In view of the present crisis in the world's affairs, and quite possibly in our own, the action of the Senate in emasculating the Chamberlain bill for the reorganization of our military forces can be regarded as nothing less than a calamity, and as liable to lead, in its ultimate results, to a great national disaster. The Chamberlain bill calls for a standing army of a minimum strength of 250,000 men, and for a Federal volunteer army of 261,000 men. The expert minds of the General Staff and the Army War College have given it as their opinion that a regular army of 250,000 men is the smallest thoroughly trained force upon which this country of ours can rely with confidence as the basis of its mobile defenses, and they believe that the proposed Federal volunteer army of 261,000 is an experiment which has sufficient promise to render it worthy of a serious trial. On the other hand, there is a unanimous consensus of military opinion that the "Federal militia" scheme, as proposed in the Hay bill, because of the existing constitutional limitation set upon the Federal Government's control over the militia, would prove to be a broken reed. And it does not require the trained judgment of the military expert to foresee that the proposed payment of from $40,000,000 to $50,000,000 a year to the militia would be to foster in our midst a politico-military institution which, under the careful mothering of the machine politician, might easily develop into that sinister "militarism" of which we hear so much in the present hour.

Now, in spite of the fact that the President has recently said: "There is nothing extravagant about an army of 250,000 men," notwithstanding that the proposed army has the backing of our highest military experts, and in total disregard of the earnest appeal of the country for *adequate* preparedness, the House of Representatives has seen fit to cut down the regular army to 180,000 men; throw out the Federal volunteer army altogether; and commit the defense of the country to a Federalized and paid militia, with all the evils of constitutional uncertainty and political abuse which may readily follow in its train.

Why is it that our military men as a whole, not a few of the members of the National Guard, and all of those civilians who have made a study of the past history and the present conditions in our state militia, are so strongly opposed to the proposed militia legislation? It is not that they are hostile to the militiamen as such, or that they fail to recognize that in some states the National Guard is a well-organized, patriotic and, so far as the limiting conditions permit, an efficient force. The objection in the majority of cases, we believe, and certainly so far as the SCIENTIFIC AMERICAN is concerned, is based upon the conviction that the whole history of our militia shows that to rely upon them as numerically the main element of our defense is to rest, as George Washington once said, "upon a broken staff."

By way of showing how diametrically opposed is the present action of the House of Representatives to the experience and teachings of Washington, we quote the following from his writings: "The jealousy of a standing army and the evils to be apprehended from one, are remote, and in my judgment, situated and circumstanced as we are, not at all to be dreaded; *but the consequence of wanting one, according to my ideas formed from the present view of things, is certain and inevitable ruin.*"

The above is from Sparks' "Writings of Washington," and from the same work we quote what Washington said in a letter to the President of Congress, dated December 20, 1776: "It is needless to add that short enlistment and a mistaken dependence upon the militia have been the origin of all our misfortunes and the great accumulation of our debt. We find, sir, that the enemy are daily gathering strength from the disaffected. This strength, like a snowball by rolling, will increase unless some means can be devised to check effectively the progress of the enemy's arms. Militia may possibly do it for a little while; but in a little while, also, and the militia of those states which have been frequently called upon will not turn out at all, or if they do it will be with so much reluctance and sloth as to amount to the same thing. . . . Can anything be more destructive to the recruiting service than granting a $10.00 bounty for six weeks' service in the militia, who come in, you cannot tell how; go you cannot tell when, and act you cannot tell where, consume provisions, exhaust your stores, and leave you at last at a critical moment? These, sir, are the men I am to depend upon ten days hence; *this is the basis on which your cause will and must forever depend till you get a large standing army sufficient of itself to oppose the enemy.*" (The italics are ours.)

Far be it from us to draw any invidious comparison between the militiaman of to-day and his predecessor who so sorely tried the patience and faith of Washington himself. Undoubtedly, the moral fiber of the modern National Guardsman is of much finer quality. But having said that, let us look squarely in the eye of the fact that the faults of the militia system, the *inherent* faults of the system, are just as great to-day as then, and let us remember that an institution which broke down so deplorably in front of the easy-going British Army of Revolutionary times would shrivel up like a wood shaving before the fierce blast of a highly trained twentieth century army equipped, as it would be, with the overwhelming artillery of modern warfare.

The hope of preparedness in the presence of this wretched fiasco in the House of Representatives lies in our President and his consciousness that he has the all-but-unanimous voice of the country behind him in his stand for an adequate army. More than once in a crisis such as this Mr. Wilson has laid a firm hand upon Congress and swung it into what he believed to be the path of honor and duty.

There is a call for such action by the President to deliver the army bill from the political toils into which it has fallen.

The Completion of the Rhone-Marseilles Canal

France, although engaged in a gigantic conflict which has called forth every military and practically every industrial resource at her command, has found time to bring to a successful consummation a great engineering undertaking, namely, the Rhone-Marseilles Canal. With the élite of her manhood engaged in the most sanguinary warfare with a military organization the like of which the world has never known before, the opening of the promising waterway at this time speaks well for the stability of the Republic's enterprises.

Marseilles is France's great port of entry for the Mediterranean Sea, although Nature caused it to be walled off from Central France by a mountainous range that sweeps around the northern side of the city. Before the advent of railroads the question of providing a waterway between the port of Marseilles and the important industrial cities in the interior was a much mooted one. As early as 1820 a canal was officially proposed by Becquey, the then director of bridges and roads. With the appearance of railroads the project was momentarily forgotten, although in the intervening years it was constantly before the French Government But it was not until 1904 that the proposals gave way to actual work on the canal. On May 7th last, in the presence of a distinguished gathering of members of the Cabinet and other officials, the Rhone-Marseilles Canal was officially opened.

The total length of the canal is 60 miles, and it has for its main feature a five-mile tunnel through a mountain. Leaving the port of Marseilles, the canal follows the coast line up to the point where the tunnel is entered. Emerging at the other end of the tunnel, the canal utilizes two salt-water lakes, the larger being the Etang de Berre, finally debouching into the Rhone at Arles. The canal in the sections on a straight line is 82 feet in width, with a depth of water of 6 feet 6 inches; the normal depth, however, is 8 feet 2 inches. Between Marseilles and the Etang de Berre it is 9 feet 10 inches, the reason for the greater depth in this section being that larger craft, such as sea-going barges, will pass through it because of the prospective development of a number of industrial establishments on the salt-water lake. From this fact it may be assumed that goods in many instances will be transhipped from the larger barges to smaller craft that ply the Rhone River. The locks of the canal are 52 feet 6 inches in width at the entrance and 525 feet in useful length. Throughout, the canal has been constructed to accommodate barges up to 600 tons capacity, and it is believed that these craft will be able to travel up the Rhone, Saône and Doubs rivers, or a total distance of 335 miles, without breaking bulk.

That portion of the canal which pierces the mountain range and is known as the tunnel of the Rove was first designed for a width of 59 feet at the springing of the arch, and was to have a towing path 4 feet 11 inches in width, forming a bracket, over the whole length. Fearing that difficulty might arise when two barges passed each other, the Marseilles Chamber of Commerce requested that the tunnel should be wider, with the result that it has been given a span of 72 feet 2 inches, with two side paths, 6 feet 6 inches in width each, leaving 59 feet for the canal width.

Perhaps the press reports regarding the official opening of the Rhone-Marseilles Canal have been too enthusiastic in visioning the great use to which the new waterway is to be put in the immediate future. The statements that the new canal, like the Kiel Canal of Germany, will be of strategic value in permitting the movement of destroyers and small war craft between the Mediterranean and the North Sea, appear to be premature, at least judging from an authoritative report on the condition of the Rhone River. The latter is a difficult waterway for traffic, and will always continue to be so. Its flow is ill-suited to modern navigation methods with large craft, yet large craft must be resorted to in order to reduce the cost of transportation. While there appears to be an abundance of water in the river, its bed is very irregular, preventing the water from spreading evenly over its entire length and breadth; and as an additional obstacle, sandbanks are constantly forming. In sum, the Rhone must be considered in the light of a torrential flood. Were it not for these conditions, direct communication by water between Marseilles and Belgium and the Rhine would be readily realized. But the obstacles that have thus far been overcome would seem to indicate that with the same kind of perseverance and skill a navigable waterway from the Mediterranean to the North Sea is not an impossible achievement of the future.

Climatology and the War

The climatic survey of the globe is an endless task, depending for its prosecution upon the patient collaboration of thousands of people. Day in and day out instruments must be read at fixed hours at an immense number of places. Month by month and year by year the results of these readings must be collated, summed, averaged at various central offices and observatories. Continuity of the records is extremely important. Missing observations may, it is true, be interpolated from the records of neighboring stations, if such exist, but the value of the series is always impaired to a certain extent by this process.

The fruit of all this labor is a body of statistics that furnishes, on the one hand, the substructure of investigations in the many branches or science in which meteorology is a factor, and, on the other, information directly applicable to the practical needs of agriculture and other human activities.

In the period of relative tranquillity preceding the present upheaval in the Old World the climatic survey was expanding at a rapid rate. Nowhere was the work more actively carried on than in the colonial possessions of Germany. Already it had become possible to draw quite satisfactory rainfall and temperature charts of such newly explored countries as German East Africa, German Southwest Africa, Kamerun and Togo. The older French and British colonies in Africa had also become climatically well known. In the Far East, in the South Seas, in South America, the spread of the climatological *réseau* went on apace. Western Europe, long provided with a dense network of stations, was turning out commendable digests of their records.

The effects of the European war upon these undertakings cannot yet be fully gaged, but climatologists already stand aghast at disasters that must be taken for granted. Germany, we hear, has managed to keep nearly all her meteorological stations in continuous operation; but what of Belgium? Perhaps some of the observers in that stricken country have heroically stuck to their thermometers and rain gages, and perhaps the enterprising Teutons have, here and there, taken up the work where the Belgians left off; but many of Belgium's longest unbroken series of observations were in progress at towns that are now heaps of ruins. There cannot fail to be a sinister gap in the copious file of meteorological reports for the kingdom which has issued for so many years from the Royal Observatory at Uccle. Northern France is in the same plight. The meteorological service of Serbia had a hard struggle to maintain its existence in times of peace. Is it conceivable that it has survived the political disasters of the past year?

What effect has the war had upon the meteorological work of the well-organized corps of observers—officials, planters, missionaries and others—in Germany's former African colonies? At the present writing it is only possible to speculate as to the effects of the war.

Electricity

An Electrically-Operated Tire Inflater of compact and readily portable design has recently been placed on the market by an American manufacturer. It is an ingenious combination of a universal electric motor that will operate on either alternating or direct current; a high-pressure air compressor; a gear box, and a condensing chamber so arranged that all elements are enclosed in a single housing, and are automatically cooled by a patented cooling system that requires no liquid of any kind. The smaller model is provided with a handle so that it may be readily carried about.

Novel Uses of Hand Magnets.— There has been introduced recently a hand magnet which is but a trifle heavier than an electric iron and is designed for connection to any lamp receptacle or socket. It is suitable for clearing up chips and borings, for separating brass from iron chips or filings, for handling warm or awkward shaped castings in foundries, for dipping metal pieces in paint, for recovering nails from sweepings in shipping rooms, and for hundreds of other purposes. A push button for turning the current "on" and "off" is located in the handle.

Rapid Screening by Electricity.—Under the name of the "gyratory riddle" there has been introduced an electrically-operated machine which permits of the rapid screening of sand and other materials. The machine consists essentially of a frame work, a one third horse-power motor, a common sieve, and the mechanical movement. The sieve is given a gyratory motion by the mechanical movement, which in turn receives its power from the motor. It is claimed that the capacity of the machine is very high, and that it will sift sand faster than a man can shovel into it. The machine is readily portable and can be operated by current from any lamp socket.

Killing Trench Rats by Electricity.— Numerous have been the methods employed by the soldiers in the French trenches to kill the rats which constitute a veritable plague in the Western war zone; but perhaps none has been so interesting—and so effective—as the electrical method. A trough is excavated along a rat-run adjoining the trenches, and over this are placed three wires running parallel to each other. A constant supply of current is maintained in the wires, which are spaced only a few inches apart. The rats in crossing the trough come in contact with the wires, resulting in immediate death. It is reported that hundreds of rats are killed each week by this method.

Electric Vibrator for Foundry Work.—To facilitate the rapping of patterns for which purpose air vibrators are now employed, there has been developed an electric vibrator of simple yet efficacious design. The vibrator is said to be especially well adapted to use on benches, squeezers and heavy moulding machines. Essentially, the new vibrator consists of a metal plunger with hardened ends, which is actuated by solenoid coils housed in a smooth, cylindrical steel case. The coils cause the plunger to strike hardened metal anvils at both extremities of the stroke. By means of magnetic force the plunger is maintained centrally in the solenoid tube; thus there is no friction and hence no lubrication is required. The vibrator is designed for alternating and direct currents.

Electric Vehicles for Wounded Soldiers.—Electric wheel chairs similar to those employed at the Panama-Pacific International Exposition last year are being used successfully in Europe for the wounded and crippled soldiers. Invariably the convalescent men prefer to direct their own chair than to have some one push them about. One of these chairs, which is of Swiss make and costs but a small sum, is equipped with a ¼ horse-power motor suspended between the steering and rear wheels. Current is supplied from a battery of 15 lead plate cells housed in three boxes beneath the seat. The battery is of 50 ampere hour capacity and provides sufficient energy for a run of 30 to 40 miles. Five forward and five reverse speeds are provided. The steering and operating mechanism is of the very simplest.

Testing of Incandescent Lamps for Government.—The lamps purchased by the Federal Government, amounting to about 1,250,000 annually, are inspected and tested by the United States Bureau of Standards. The specifications, under which they are tested, are published by the Bureau and are recognized as standard by the manufacturers as well as by the Government. They are used also by many other purchasers of lamps. The lamps are first inspected for mechanical and physical defects, this being done at the factory by Bureau inspectors. Representative samples are then selected and sent to the Bureau, where they are burned on life-test at a specific efficiency at which they must give a certain number of hours life, depending upon the kind of lamp. About 5,000 lamps are thus burned on test each year. For this test great care must be taken in the measurement of the lamps and the adjustment and regulation of the life-test voltage.

Science

Instruments for Measuring Solar Radiation.—Instruments of this category have increased considerably in number and efficiency in recent years, but the literature concerning them is scattered through the files of scientific journals and is not easy of access. We therefore welcome the appearance, in separate pamphlet form, of a comprehensive history and description of such instruments by Mr. Robert S. Whipple, originally published in the *Optician and Photographic Trade Journal*. The memoir is fully illustrated and provided with bibliographic references.

A Flora of the Northwestern United States.—Messrs. C. V. Piper and R. K. Beattie have recently published a much-needed addition to the list of American floras in the shape of one for the part of Washington and Oregon lying west of the Cascade Mountains and between 43½ and 49 deg. N. latitude. The northern range of many of the species extends well within the boundaries of southern Alaska. The work includes descriptions, with keys, of 1,617 species, of which seven are new to science. The work is based largely on herbarium material at the State College of Washington.

Crow Roosts.—Writing in the *Yearbook* of the U. S. Department of Agriculture, Mr. E. R. Kalmbach, of the Biological Survey, describes "one of the most wonderful of bird phenomena still existing in close proximity to large cities" in this country; viz., the "roosts" at which crows gather nightly in enormous numbers during the colder months of the year. A roost is usually a stand of trees, especially pines and other evergreens; though one of the most populous of the earlier known roosts was a low, reed-covered island in the Delaware River, entirely destitute of trees, known as the Pea Patch. Crows have also been observed roosting in open fields and on exposed sand bars. Roosts are often in the immediate vicinity of cities. One at Arlington, Va., just across the Potomac River from Washington, was supposed to have contained at the height of its occupancy from 150,000 to 200,000 birds. Several other equally populous roosts have been recorded, while some observers have estimated the population of individual roosts at millions. Fortunately the birds that gather in one spot in such numbers at night feed over a wide area, as a rule, by day, so that the roost is not so serious a menace to crops in its vicinity as might be expected.

Upper-air Observations in Canada have now been in progress for more than five years, the first sounding-balloon having been sent up from Toronto, February 3rd, 1911, and the first meteorological kite February 28th, 1911. The Canadian Meteorological Office has just published, in one volume, the detailed results of all the balloon observations down to April, 1915. The majority of the balloons were sent up from Woodstock, about 100 miles WSW of Toronto. As indicating the drift of the atmosphere in that region it is interesting to learn that only four balloons were found, after their fall, west of the starting point. The mean direction of travel was due east. Of 94 balloons sent up, 53 were recovered. In one case the balloon was not found until 13 months after its ascension, but its meteorograph record was still quite legible. The results agree with those obtained in Europe in showing that the stratosphere or "isothermal layer" of the atmosphere is higher in summer than in winter, but differ from the European results in showing the stratosphere to be warmer in winter than in summer, the average seasonal difference being 6 deg. Cent. This is possibly due to the fact that Ontario, where the observations were made, is east of a continental area, while Europe is east of an oceanic area.

Thunder at Sea.—In consequence of a note published in the SCIENTIFIC AMERICAN of June 19th, 1915, recording a discussion at meetings of the Astronomical Society of France in regard to the audibility of thunder at sea, the Carnegie Department of Terrestrial Magnetism instructed Captain Ault, master of the "Carnegie," to investigate this question in the course of a voyage from Dutch Harbor, Alaska, to Port Lyttleton, New Zealand, August 6th-November 2nd, 1915. Lightning storms or displays were seen on twenty-two different occasions, but they were accompanied by thunder on only six occasions. In these six cases the distance of the nearest land was from 50 to 600 miles. In all cases, however, where streak lightning was seen, thunder was also heard. The other cases were sheet lightning. It has been suggested that the frequent inaudibility of thunder at sea may be due to the fact that the sound of the thunder is drowned in the noises on shipboard during a storm. The "Carnegie," however, observed lightning without thunder several times in calm weather. In one case in which several claps of thunder were heard, the successive intervals between flash and clap showed that the storm became inaudible when its distance exceeded 5 miles from the ship. The observations will be continued during the remainder of the present cruise of the "Carnegie."

Aeronautics

More Powerful Aeroplanes for Army.—The War Department has decided to abandon the old 90 horse-power aeroplane for military use except in the training schools, due to the experiences of the aviators in Mexico. Orders have been placed for four new Curtiss biplanes of 160 horse-power, conditional on satisfactory tests that are to be conducted at Newport News. It is known that the new machines are considerably larger and have far more lifting power. Their speed is as high as 95 miles an hour.

The Society of British Aircraft Constructors has recently been founded in England and has among its numerous objects "to encourage, promote and protect the British aircraft industry and generally to watch over and protect the general interests of companies, firms and persons engaged in such aircraft industry, but independently of the personal interests of any company, firm or person." It proposes, too, to originate and promote improvement in the law concerning aviation, to support or oppose alterations therein, and to effect improvements in administration. It is also proposed to maintain a statistical department which will collect and collate statistics relating to the industry.

Electrically-Heated Gloves for Aviators.—A British firm has recently introduced a line of electrically-heated gloves for aviators. Cold hands and feet are among the prime discomforts experienced by airmen flying at high altitudes, and it is obvious that numbed hands in particular may lead to disaster. Ordinary gloves, irrespective of their thickness, are of little use. The electrically heated gloves, on the other hand, maintain the hands at a comfortable temperature. As in the instance of the electrically heated gloves for automobile drivers, electrical connection is made between small brass disks on the gloves and metal plates on the steering-wheel of the aircraft.

Why the Navy Needs Seaplanes.—Aeronautic units are to be developed within the United States fleet for the purpose of directing the fire of battleships at extreme ranges. With seaplanes it is expected that effective fire can be maintained at a distance of 17,000 to 18,000 yards, according to the *Aerial Age Weekly*, which states further that the naval engagements in the North Sea indicate that there has been effective firing at 17,000 yards. In the spring target practice of the United States Navy it is thought that, with the assistance of seaplanes, by which the range can be corrected and the result of shots observed, interesting results may be obtained.

Engagement Between Submarine and Seaplane.—Anthony Jannus, an aviator and representative of an American aircraft builder, tells of an interesting engagement between a submarine and seaplane which he witnessed while on board a Russian ship during the aerial bombardment and destruction of the Turkish Black Sea port of San Godac. He states that a Turkish submarine had crept up unobserved on a Russian seaplane which was resting on the surface, and launched a torpedo. The missile grazed one of the planes, but did not explode. Before the submarine could dive, however, the seaplane arose and with accurately aimed bombs destroyed the submarine.

Record Non-Stop Flight of Army Aviators in Mexico.— Lieuts. Edgar S. Gorrell and Herbert A. Dargue made a record non-stop flight and brought in messages from the front to Columbus, New Mexico. For several days we had been without information regarding what was transpiring with the flying column of cavalry, owing to the insufficient range of the field wireless. Consequently, when these two intrepid aviators arrived with messages for General Funston, every one was greatly relieved. For their flight the aviators used one of the five 90 horse-power Curtiss tractors that are still in commission out of the eight with which operations were begun in Mexico. They averaged nearly 90 miles an hour, which was extremely good considering the treacherous air currents in the mountain districts.

Teuton Air Losses in the War.—Estimates of German and Austrian air losses since the inauguration of the war are as varied as they are numerous. Among the latest is that of the Italian *Giornale dei Lavori Pubblici*, which states that definite news has been received from a most competent source that since the beginning of the war Germany has lost 47 Zeppelins and 368 aeroplanes, the number of airmen killed or captured in connection with these losses being 1,400. Germany has constructed 40 new Zeppelins; over 30 of these are now in service and the remainder are nearing completion. Austria is said to have lost all her dirigibles and 184 aeroplanes, and has not been able to replace the former. Since the article in which these figures were published appeared some two months ago, the losses shown do not include the heavy toll in Zeppelins and aeroplanes recently exacted by the Allied forces. However, it would seem that the figures given are somewhat higher than the usual run of estimates.

Industrial Preparedness for Peace

VII. Cutting Costs in the Paper Mill

By Miner Chipman

THE price of paper in all lines has risen to figures running from 50 per cent to 100 per cent higher than those prevailing before the European War. High grade bonds which previously retailed for 25 cents or 26 cents per pound, are now selling for 50 cents per pound, with little to be had at that price. The paper mills are rushed with orders, and crying for raw material. The raw materials shortage includes foreign rags, foreign sulfite, and foreign chemicals, dyes, etc. One of the largest printers in the country has told me that the printing business was having a boom, notwithstanding the tremendous increase in the cost of materials. Many of our paper manufacturers are awaiting the close of the war, that the avenues of trade may reopen, and thereby bring their production up to normal. This "waiting" program is not Industrial Preparedness for Peace. We cannot include under this heading of Preparedness, the mere development of local producing agencies for these raw materials which have been heretofore exclusively imported. The program for Industrial Preparedness goes much deeper than that.

The slips of paper in the roll indicate "side cracks." A side crack means a stopping of the machine, pasting the ends, and restarting

Scientific Management in Paper Making

The application of the principles of scientific management to the manufacture of paper is quite different from that of applying the same principles to machine-shop processes. The division of labor, found in machine trades, has not been, and never will be developed in the paper mill. A division of labor exists, but such divisions as exist cover trades in themselves, with their own distinctive technique. In a general way, paper making may be divided into the following classification, as to its educational or experimental content, as an occupational problem:

(1) Chemistry. (2) Mechanics. (3) Manual Labor. (4) Mental Labor. (5) Trade Technique.

Nearly every job in a paper mill contains elements of these five divisions. The paper mill is a process of almost infinite variables. About the only constant factor in a paper mill is trouble, and even this has a vexing variation. The making of a particular grade and quality of paper is not the same proposition as that of manufacturing a certain gear, wheel, or machine part. There is nothing "fixed" in paper manufacture. One of the most impressive and interesting mechanical processes in modern industry is the operation of the modern high-speed paper machine. The "machine" is the heart of the mill. Its production regulates all other processes in the mill. Everything else is in dependent sequence to the paper machine's efficiency and production. Scientific management has been applied, with success, to the operation of this important factor in paper manufacture. A modern paper machine costs, including housing, anywhere from $100,000 to $250,000, and paper-makers have left no stone unturned to plan orders and despatch them to the "machine" with the least possible delay. In a large mill manufacturing fine book papers, the average shut-down of paper machines did not exceed 2 or 3 per cent in an entire month. The opportunities for savings and increased efficiency in the paper mill do not lie in the operation of the paper-machine itself, but in the numerous and complex operations which precede and follow the paper-machine as a factor of production.

One of the largest paper manufacturers in this country employed an efficiency expert to make a survey of his mill, and introduce the principles of scientific management, where practicable, into its operation. The story of the efficiency work carried on in this mill is one of the most interesting chapters in the history of scientific management. As an example of Industrial Preparedness for Peace, a brief description of the work, as applied to the single operation of calendering, will give an adequate conception of the possible savings in paper manufacture. These savings are possible, entirely outside the raw material problem, and bear no relation whatsoever to European conditions, German competition, or the dyestuff problem. The savings made in this department of a large and prosperous paper mill illustrate the general possibilities in the trade as a whole, and the kind and character of savings, which we include under the term of Industrial Preparedness for Peace.

Calendering Coated Paper

This process may be divided into any number of operations. For convenience, we have classified it under six different headings:

1. High speed.
2. Slow speed.
3. Breaks in paper, pasting ends, etc.
4. Making ready.
5. Taking sample.
6. Unavoidable delays.

Any operation that a workman performs about his calender may be placed under one of these headings. We shall explain each one separately:

1. *High Speed.* When a calender is on its high speed, with the weights down and the paper running smoothly, it is doing productive work. All the other operations are merely side issues necessary to bring the stack (calender) to the desired condition, *i. e.*, of running on high speed. It follows that all items such as low speed, pasting ends, making ready, etc., should be made as short as possible so as to increase the time on high speed.

2. Low speed is necessary in starting, or when a poor spot in the paper is about to pass between the rolls.

3. Breaks in paper, pasting ends, etc. Under this heading we have included all of the time from the stopping of high speed (in order to mend a break or paste an end) until the high speed is again started.

4. Making ready includes the time from the finish of high speed on one roll until the starting of high speed on another. It includes such operations as (a) taking finished roll out of bearings, (b) placing finished roll on rack, (c) placing new roll in bearings, (d) putting paper through stack, and other features.

5. Taking sample—(for inspection of foreman).

A roll of paper like this causes high cost to the manufacturer, reduction in output, loss of bonus to the worker, and a high percentage of waste

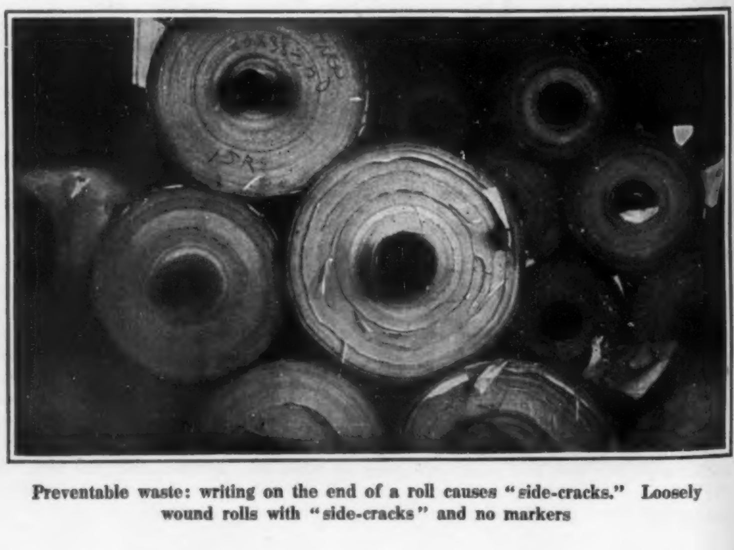
6. Delays. This heading is inclusive of delays, for which the operator is not responsible, such as interruption of powder.

The first step in standardizing the work of calendering was to bring the machines up to standard speeds. This was accomplished with such success that the average speed of the 19 machines showed an increase of 90 feet per minute. This means an increase in output of 375 pounds of paper per hour.

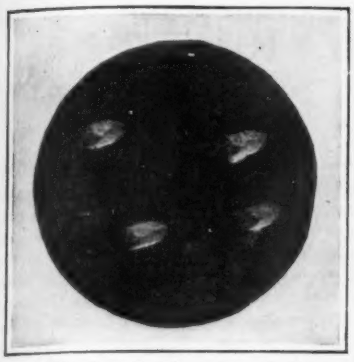
Careful studies of the various machines were then made and a standard of efficiency established for each, indicating the percentage of the operator's time which should be devoted to each of the six fundamental operations described above. It was then possible to maintain a close watch over each machine, and make intelligent efforts to keep it running at high efficiency. It should be noted that under this system a machine may attain an efficiency of more than 100 per cent simply by exceeding the standard laid down for it.

(*Concluded on page* 542)

One of the causes of high-cost. Loosely wound rolls are difficult to calender, causing delay, inefficiency and waste

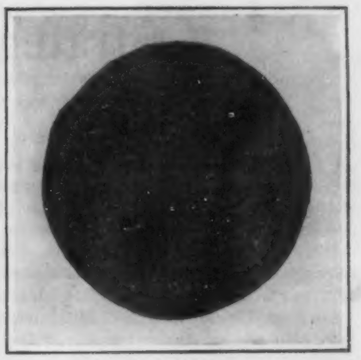


Preventable waste: writing on the end of a roll causes "side-cracks." Loosely wound rolls with "side-cracks" and no markers



A badly dented piece of wood before treatment

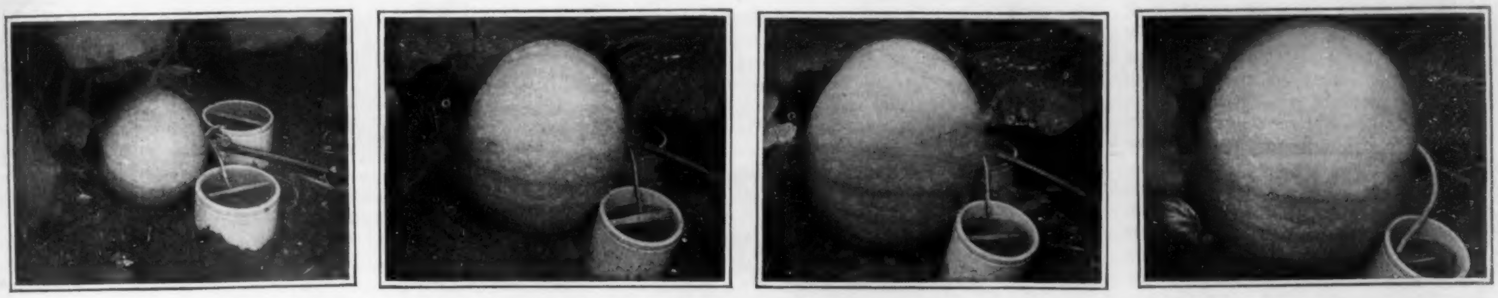
Removing dents from furniture with damp blotting paper and a hot iron



After treatment repolishing will clear away the slight marks

Removing Dents from Furniture

WHEN wood is badly dented or scratched it is often a problem to know how to get rid of the marks. This is quite easy if the following plan is adopted. First of all fold a piece of blotting paper at least four times; then saturate with water, finally allowing the superfluous moisture to drip away. Now heat a flat iron until it is about the warmth required for laundry work. Place the damp blotting paper over the dent and press firmly with the iron. As soon as the paper dries examine the mark. It will then be found that the cavity has filled up to a surprising extent. Where the dent is very deep a second, or even a third, application on the lines indicated might be tried. Sooner or later even serious depressions can be drawn up, and most people who have not tried this plan will be surprised at the result of the treatment. The accompanying photographs show a dented piece of wood before and after the application of the iron. Re-polishing will clear away even the slight marks that might finally remain.



How the pumpkin fattened on the sugar solution. Photographs made on successive days from September 4th to 7th inclusive

Feeding a Pumpkin with a Sugar Solution

By S. Leonard Bastin

SOME interesting experiments have been recently carried out to prove that the growth of gourds and pumpkins may be accelerated by artificial means. It has for some time been known that many plants greedily absorb sugar solutions, but it is only recently that the idea of feeding a growing pumpkin has been developed.

The plan is carried out in the following manner. A healthy young fruit is selected for the experiment a few days after it has definitely "set." Next, a very strong sugar solution is prepared in the following way: One or more jars are taken and each of these is filled with water. Raw sugar is then stirred into the water until the liquid has absorbed all that it can take up. The sugar and water should not be boiled, as this will produce a thick mixture that will not be freely imbibed by the plant. On the other hand there is no harm in order to assist in the dissolving of the sugar if the water is slightly warmed.

The next thing is to secure some pieces of cotton through which the sugar solution will pass. Actually round cotton lamp wick answers the purpose very well. It is a good plan to use not less than a couple of jars of solution for every pumpkin. These are stood one on either side of the fruit, sunk a little into the ground, so that there will not be a danger of overturning. A connection must now be made between the pumpkin and the sugar solution. Two pieces of the wick are cut, these being measured so that they reach from the stalk of the pumpkin well down into the mixture in the jars. It is now needful to prepare the openings in the stalk so that the free ends of the wicks can be inserted into the tissue. The holes may suitably be worked out with a penknife, care being taken to avoid penetrating the stalk right through at any point. When the holes have been opened up the ends of the wicks are fitted in such a way that they are pushed well "home" into the openings. Nothing now remains save to see that the jars are well supplied with sugar solution. The contents of the jar is well stirred two or three times a day in order to prevent a large amount of sugar from settling to the bottom.

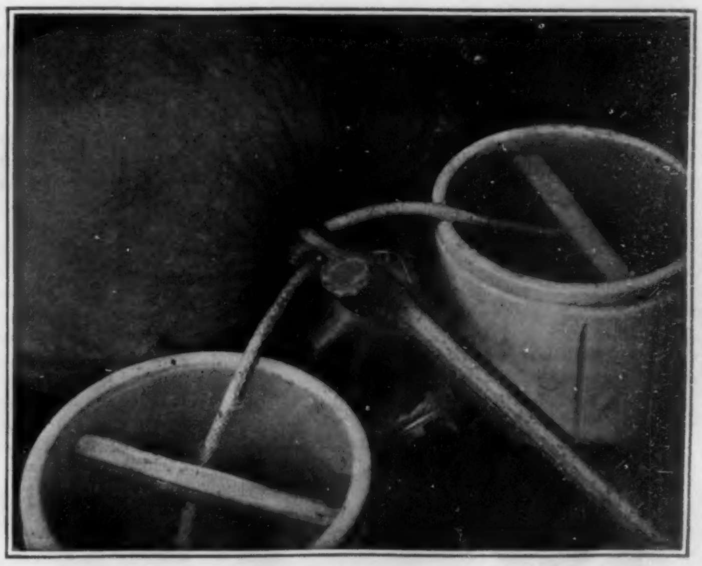
The rate of growth evidenced by the pumpkin is astonishing. It will be found that the fruit grows three or four times faster than those specimens which are not fed at all. It is easy to find out the increase in weight by placing the fruit on to a pair of scales from time to time. Care must be taken to avoid injuring the stalk in any way. As regards the increase in size a glance at the accompanying photographs will show how the pumpkin jumps when it gets its first taste of the solution. Within certain limits there does not seen to be any reason why pumpkins should not be grown in this manner to almost any magnitude.

New Serum for Restoring Life to Apparently Drowned Persons

SEVERAL physicians of the Johns Hopkins Hospital of Baltimore, Md., are at present experimenting with a serum which they are said to have used with success in the laboratories in restoring cases of asphyxiation and drowning in animals several hours after life has been practically extinct. There appears to be one drawback in the results thus far, however, in that in the majority of instances there have been serious after effects such as high blood pressure or hardening of the arteries.

If the serum is to be perfected, and more than likely it will be, the physicians are of the opinion that it can be injected into human beings several hours after the accident and restore them to life. In one case the serum was used on an animal that had been apparently dead from drowning for a period of four hours. The animal was brought back to life, but it died a short while later from blood pressure. Other cases, report the physicians, have been successful.

How the pumpkin was weighed on a small scale



The sugar solution was fed through cotton lamp wicks

Strategic Moves of the War, May 12th, 1916

By Our Military Expert

AFTER a lull of inactivity in the Verdun sector, a pause which has almost universally been accepted as final acknowledgment that it is a physical impossibility, with the forces available, for Germany to break the lines of General Petain, powerful attacks have again been directed upon that part of the French defenses, in particular west of the Meuse.

Le Mort Homme and Hill 304 have figured prominently in the war dispatches. By putting two and two together, comparing various admissions of attack and claims of defense, it is evident that the constant hammering of the Kaiser's troops against the lines of their adversary has resulted in a slight beating back of the French positions which were not long since fairly well extended down the slopes of these important hills. The German position seems to have bent itself around these two eminences, dipping into the valley between them, until the outline of their advanced position resembles the form of a Cupid's bow, the handgrip being represented by the thrust into the ravine, the tips of the bow embracing the northern and flank portions of the hills.

The German method of attack has lately become that expensive one of blanketing the entire position about to be assaulted under a heavy concentration of artillery fire, the employment of hundreds of thousands of high explosive shells.

It is too much to expect that anything could live under the rain. The French trenches were absolutely obliterated, and when the Germans thought the propitious moment had arrived, tremendous forces moved quickly forward to occupy the line of craters, the former trenches.

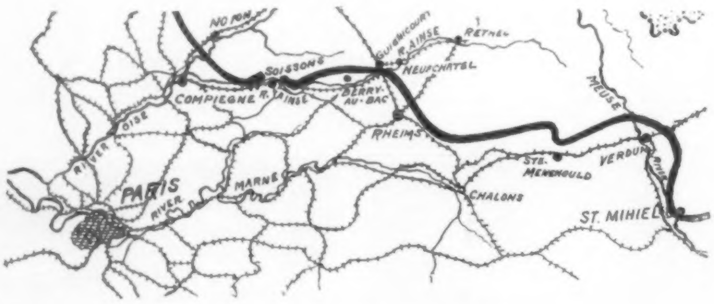
The French method of defense, however, has been deadly. It appears that fewer and fewer troops are left to hold the first line trenches with each day of battle; but the bulk of the containing force remains snugly under ground until the infantry assault is about to reach its objective, when a thousand shell-proofs and craters give up the greatest military factors of the war—after the artillery—machine guns. It is absolutely impossible for infantry not under cover to withstand the sweep of these weapons if they are in sufficient number adequately to cover the position; and the French, according to report, have introduced the automatic rifle into service, practically a hand machine gun.

Hill 304 has been acclaimed the key to the French position by many analysts of the operations in the sector. But an observer recently returned from the actual theater of war, one who has seen with his own eyes the lay of the land and to whom the actualities of the position have been explained by French officers of high rank, has made the definite statement that the real lines of defense west of the Meuse—and the real defense of Verdun does lie west of the river—is to be found in the grim line of hills and plateaux several miles to the southward of Le Mort Homme and Hill 304. In effect this makes these latter hills but advanced posts of defense, positions strong enough in themselves to serve as barriers if properly held, but which can be given up without appreciable damage to the real defense of the city, or, more accurately, the principle of holding Verdun, for as a city it no longer exists.

The renewed activity seems more of an attempt to retain the French defenders in position while other affairs of moment are brewing, than confident attempt to break the line. For weeks on end Germany sought to reach a decision favorable to herself by a monumental thrust at the Verdun salient. Blood was poured out like water in the attempt, reserves of munitions were expended unstintedly, but without effect. The retirement of the defenders to more defendable positions was but a logical and scientific move and it cost nothing but the surrender of a few more miles of French territory which had become nothing but a shambles.

The vicinity of Soissons and Compiegne lies much nearer to Paris than that of Verdun. It is almost due west from Verdun, this vicinity, about 160 kilometers, and the little items of activity which have been dribbling in for the past ten days seem to indicate great as yet unfathomed activity in this direction. If it is part of the Teutonic plan to swoop down upon the Soissons sector, naturally its directing genius would calculate for every advantage to accrue. For this reason it must be the part of strategy to keep the adversary in doubt as to his intentions; whether to retain full strength at Verdun in case the latest attacks should, after all, be but another attempt to reach decision at Verdun; or whether to shift his forces westward to meet a new attack much closer to Paris, the heart of France.

The sector embracing Soissons is officially known as the Soissonais; that immediately touching it to the northwest is Santerre, through the center of which runs the Oise. It is almost at the juncture of these divisions that the lines meet in the greatest salient of all, the particular point which is nearer Paris than any other. There has been little report of activity in these sectors; but for all that, trench warfare of a sanguinary sort has obtained here throughout the war. The mere spectacle of massed and sustained assault has been lacking. But at this point is to be found one of the strongest natural positions of the entire line, especially along the Oise. Great forests and interlocking hills render the locality forbidding to attack, and so far it has been practically unmolested. The valley of the Oise, however, offers a tempting avenue of approach to Paris, one of the most feasible in existence if the line can be successfully forced. The salient offers as much of a threat against Paris as Verdun does against Metz—and the entrance to Lorraine. It is, above all, the most likely point of attack in a drive upon Paris. This is so universally recognized—and so anticipated by France that the lines of fortification in the vicinity have been made of surpassing strength—and resultantly they have been completely ignored by the Germans in their various plans of operations.



Relation of the battle front to Paris

Where the Germans are pounding at Verdun

This is no forecast of future movements; only a plain statement of fact. It seems as though a German movement of tremendous magnitude is under preparation somewhere in the vicinity; where it may break—if it does break—no one can say, but with every element of the war, every factor of time, necessity and desired achievement centering upon the desirability of a speedy decision somewhere, anywhere, it seems probable that the shortest line may not be longer ignored.

It is not at all improbable that another great German attack will be made somewhere between Verdun and the Channel. England has taken over the French trenches as far south as the river Somme—possibly farther to date—releasing thereby considerable French forces for use at Verdun. The forces of Great Britain afield, counting those actually on the line, in general reserve and on the lines of communication, probably number 1,500,000 men. France, deducting all losses up to the present, should have in the vicinity of 2,000,000 combatants, thus giving the Entente forces available on the western line the superior number of 3,500,000. Germany's available forces may be counted as about 4,000,000. But when one figures that a considerable portion of these are detached against the Russian line, holding that part of it which Austria-Hungary is not, it cuts severely the numbers available for use in the west. In all probability, then, Germany is outnumbered in France in about the proportion that Germany outnumbered France during the earlier months of the war. But neither France nor England, nor both, are as yet able to meet the German superiority of heavy artillery, and this is a factor which will count heavily when the initiative is finally taken by the Allied troops.

While German blood has been shed in such profusion that in places the lines are tenuous because there are not enough men to occupy them in force, her heavy artillery material is intact and more numerous than ever before, while her munition factories have worked incessantly to turn out the necessary shells for their feeding.

It may be that the disparity in this respect has been remedied; France and England may have managed to get out a sufficient number of heavy guns to meet their requirements, but it is to be doubted. If the long-heralded allied offensive is opened within the next few weeks the greatest reliance will probably be placed upon numerical superiority, with full consideration having been given to the big losses which must ensue.

The Current Supplement

A MOST interesting article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2107, for May 20th, is *The Military Rifle*, which surveys the history of the development of the breech mechanism of the rifles used by the armies of the different nations, and gives an illustrated description of the principles and details. There is another instalment of the valuable lectures on *Radiations from Atoms and Electrons*. *Thorium*, tells of the method for obtaining this rare earth which is the principal constituent of gas mantles. An article of much interest is that on *Artificial Limbs* which describes and illustrates a number of devices for cripples to enable the wrecks of the European war to lead useful lives. It is profusely illustrated. A third article of the valuable series on *Economy in Study* appears in this issue, this chapter treating of books and their educative use. *The Rennerfelt Electric Furnace* describes and illustrates a device that has been found very successful in Sweden for steel foundries. There is an article on *A Coating for Blue-Print Paper* that will be appreciated by many as it describes an entirely new method. *How to Value Gems* describes the characteristics of a large number of precious stones and will be of general interest. There are also a number of shorter articles on subjects of wide interest.

Compression Test for Keel Block

AN important test was conducted recently by the United States Bureau of Standards to determine the ultimate strength of a cast iron keel block. As designed, the block was expected to withstand a load greater than could be exerted by any testing machine in existence. It did withstand the full capacity of the Bureau's testing machine (10,000,000) when the load was applied over the entire bearing surface of the block; but when the load was applied over part of its bearing surface, it failed at 9,600,000 pounds.

The test of the block itself was preceded by several preliminary tests to determine the strength of oak timbers, which are usually placed between blocks and the keel of the ship. At loads from 300,000 to 800,000 the timbers were completely shattered, the variation in the load depending entirely upon the variation in the area over which the load was applied.

After these preliminary tests the keel block was subjected to a load equal to the capacity of the machine. At about 6,500,000 pounds several sharp reports were heard, but after the full load was applied there was no apparent damage to the exterior of the block. On dismantling it, however, it was noticed that several of the webs of the various sections were cracked. It was then reassembled, and the load applied over a smaller area when it failed at 9,600,000 with a very loud report and almost complete shattering of the various sections, throwing parts of them to a distance of 12 feet.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Shackleford Post Roads Bill

To the Editor of the SCIENTIFIC AMERICAN:

The Shackleford Post Roads bill passed the House in the present and previous Congresses. It is now referred to the Post Roads Committee of the Senate. The bill calls for a federal appropriation of $25,000,000 to be given states and communities to assist in the construction and maintenance of post roads, i. e., rural mail and star routes.

To a cursory observer this epoch making measure would be passed up as inadequate. The $25,000,000 would appear a mere drop in the bucket, and so it is when one compares the "drop" with the enormous amount of state and county funds poured in taxes, yearly, into the "bucket" of the nation or "buckets" of the states and counties of the nation. Anyway, it will make radiating circles when it does drop; and it can't begin dropping too quick.

The Shackleford bill, if it becomes a law this session, will have a tendency to make more efficient the mail service of the nation. It ought therefore to appeal to the wisdom of the Post Roads Committee of the Senate and be reported favorably out of committee.

All post roads emanate from railroad towns primarily, because the railroads carry the mail. The railroads also carry the commercial sap of the nation, the waybill that goes with this sap, the invoice, the letter, the bill, the dun, the soliciting letter and the catalogue. Along the railroads, too, are stretched the afferent and efferent nerves of commerce, the telegraph and telephones wires, which regulate the flow of this commercial sap, so that an impingement at any point can be readily felt and located. Freight consigned to railroads travels safe and secure under seal, train dispatcher and conductor till it reaches its destination. It follows, therefore, that the railroads will, for some time to come, continue to be the commercial highways of the nation. They are equipped for this. The towns also supplied with this commercial sap along the railroads will continue to increase in population and wealth. Population and wealth mean taxes and revenue.

In 1830 there were only 23 miles of railroads in the United States. West of the Alleghanies was a trackless waste, producing a daily crop of dew, which was uncollectible, and yet that was what our $15,000,000 investment in the Louisiana purchase of 1803 was paying us in 1830 and even later.

Since Congress began to help the railroads to cross the trackless plains up to date a vast increase in land values has arisen. One can walk all day inside "The Loop" in downtown Chicago and, bargain as he may, no block can be purchased for less than $15,000,000. Dollars have taken the place of dew in forest and on prairie. Towns have sprung up, an average distance of 5½ miles apart, on 350,000 miles of railroads; 2,300,000 miles of roads have been built up to those railroad towns, and of those 2,300,000 miles of roads the Government decided to select the most frequented so as to deliver the farmer his mail. This was seventeen years ago. To-day there are 1,100,000 miles of rural mail and star routes, or practically half the total mileage of roads.

To me the improvement of these 1,100,000 miles of rural and star routes is as simple as the Rule of Three.

If through unbroken prairie and forest the pioneer farmer and county court, with little or no funds and only using the mincing pick and shovel, could designate and build through sparsely settled territory 2,300,000 miles of roads, how long will it take the greatest nation on earth, with an ever increasing population (now 100,000,000), increasing revenue and mammoth road machinery, to hard-surface just half of 2,300,000 miles of road? Well, if we have done the one in practically fifty years, we ought to do half in twenty-five years, and in much less time if the pick and shovel are set aside for road machinery.

Therefore it does not look a tremendously big job to hard-surface 1,100,000 miles of post roads after all. Look at what the county court has already done!

But suppose we build hard-surface stretches of road past every rural mail box in the United States, there still remain gaps to be filled in along the interborough highway, where the rural mail wagon turns off at right angles to the road to circle and zigzag its way back again to town. It is plain this would be a hindrance to interborough traffic and travel wherever such gaps should exist. That should be easy. Correct the gap, let it be a rod or a mile, and *there you are.*

The average number of rural mail routes emanating from station stops on railroads in mid-west and eastern states are three to a station stop. This is easily verified by the Post Office Guide. Now, as each rural mail route averages from 20 to 25 miles in length, such routes ought to interlace and overlap along this interborough highway. Wherever they don't, a certain adequate amount of federal, state and county road building funds should be set aside to connect them; for, by doing so, interborough highways for traffic, travel and military purposes are thus provided for.

All railroads in the United States are military highways so strong that all the men and munitions that followed Alexander the Great, Hannibal, Cæsar, Napoleon, and "those that crossed the sea and drew their sounding bows at Agincourt"—even including the expeditionary forces of to-day—could cross and recross them to-day and add nothing but *a polish to the rail.* But at bridge, trestle and tunnel they are vulnerable. A bomb dropped from an aeroplane or Zepellin could blow up bridge, trestle or tunnel and thus block an army from our interior posts rushing to the defense of a coast town to prevent a landing of 400,000 trained troops.

There is no use in the Government spending money unless some big national object is gained thereby. Such an objective as the securing of supplemental commercial mail and military highways by the additional expenditure of enough money to build the connecting links between rural mail routes along our *best military highways*, the railroads, should appeal to all thinking men. It is scientific and not haphazard road construction. It is thorough and American. To obtain this objective a federal highway engineer should be appointed to fill a federal highway department, similar to some state highway departments. He should take under him every state and county engineer, find out to a cent how much money is available in state and county for road construction, add thereto the federal proportion, and say: "Gentlemen, build in this and that direction eight (ten or twenty) miles of post road and interborough highway." That's all. He holds the plans.

Roads and highways thus built, following a general plan, would obviate the confusion and lack of design of independent county and state road construction. The state and county engineers are restricted in their work by state and county lines.

Let me illustrate: A cobbler had a piece of leather to fit a shoe. It was not broad enough. He remarked, "There's always a bit o' leather in the hammer." He placed the bit of leather on the lap-iron and hammered it till it spread to fit the place.

Now, with federal aid representing the hammer, the state represented by the lap-iron and the county road building fund represented by the leather, an intelligent cobbler (federal engineer) should plan and hammer till the gaps between railroad towns along the interborough highways be also built.

The Shackleford bill is incomplete until such provisions are made. P. H. DALY.

New York city.

How the United States Weather Bureau Was Started

By Cleveland Abbe, its Founder and Organizer

MY boyhood life in New York city had impressed me with the popular ignorance and also with the great need of something better than local lore and weather proverbs. The popular articles in the New York daily papers by Merriam, Espy, Joseph Henry and others—notably Redfield and Loomis—had by 1857 convinced me that men could and must overcome our ignorance of the destructive winds and rains. It was in the summer of 1857 (1858?) that I read the beginning of the classic article by William Ferrel in the "Mathematical Monthly." I realized that he had overcome many of the hidden difficulties of the theories of storms and winds. From that day he was my guide and authority. During 1859-1864, in the practice and study of astronomy with Bruenow at Ann Arbor and Gould at Cambridge, Mass., I was impressed with the unsatisfactory state of our knowledge of atmospheric refraction. Two years later my experience at Poulkova, Russia, and at our Naval Observatory, Washington, seemed to justify my conclusion that astronomers who would improve their meridional measurements must investigate their local atmospheric conditions more thoroughly, and to this end must have numerous surrounding meteorological observations. In my inaugural address at Cincinnati on May 1, 1868, I stated that with a proper system of weather reports much could be done for the welfare of man, and astronomy also could be benefited.

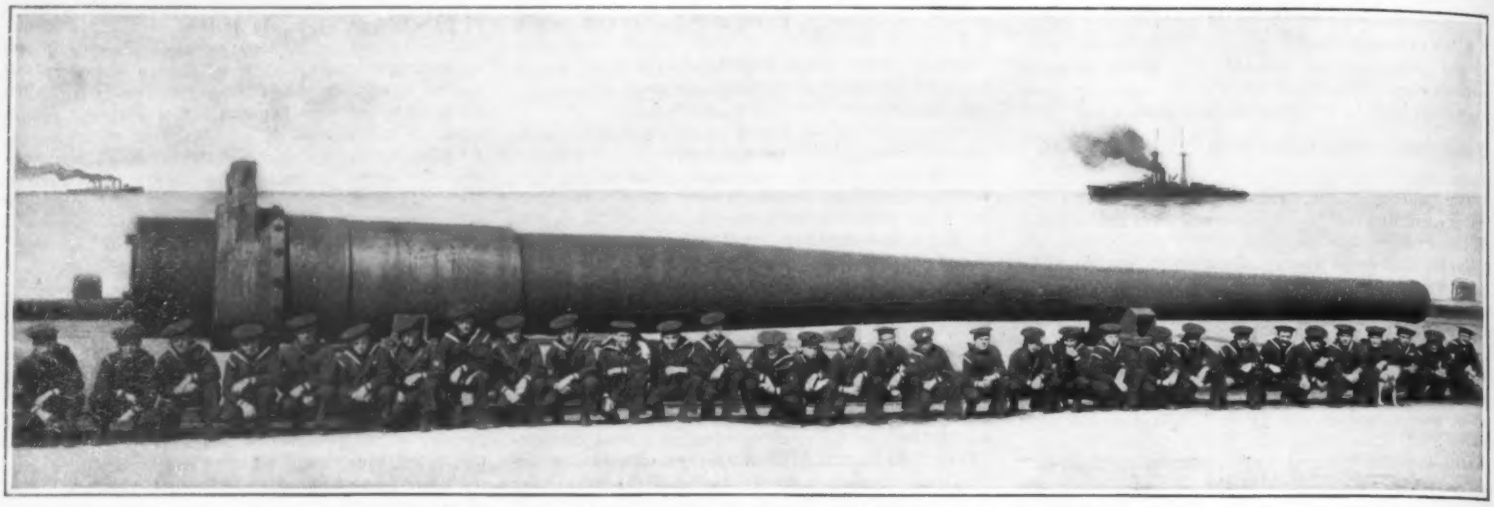
This suggestion was taken up by Mr. John Gano, president of the local Chamber of Commerce; a committee met me, approved my plans and promised the expenses of the first trial. I had the total solar eclipse of August 7, 1869, on my hands, but immediately began to arrange for forty voluntary meteorological correspondents. On my return from the eclipse at Sioux Falls city I stopped at Chicago and formally invited the Chicago Board of Trade to join in extending the Cincinnati system to the Great Lakes, but this invitation was declined by the Chicago Board of Trade. An editorial in a Chicago evening paper of Monday, August 16, 1869, stated the scientific basis of our observatory work. I returned at once to Cincinnati, issued the first number of the Cincinnati Weather Bulletin promptly, as promised, on September 1, 1869; it contained only a few observations telegraphed from distant observers and announced "*probabilities*" for the next day. This bulletin, in my own handwriting, was posted prominently in the hall of the Chamber, but unfortunately I had misspelled Tuesday, and I soon found below my Probabilities the following humorous line by Mr. Davis, the well-known packer, "A bad spell of weather for 'Old Probs.'" This established my future very popular name of "Old Probs."

My forecasts were treated very kindly by all. I had anticipated a slow increase in accuracy; I ventured to write my father in New York city, "I have started that which the country will not willingly let die." I wrote a short note to the New York *Times* (or *Tribune*), telling them how useful we could be to their shipping. On September 3, 1869, I even ventured to offer a daily telegram by the French cable to Le Verrier as founder of the "Bulletin Hebdomadaire de l'Association Scientifique," and who could fully sympathize with my hopes and plans. He realized the breakers ahead of me better than I. My daily telegram from Milwaukee came from the well-known Smithsonian observer and author, Prof. Increase Allen Lapham. He had known and appreciated the works of Espy, Redfield, Loomis and others, and although he had become absorbed in other studies, he urged the local Milwaukee society to do something for Lake Michigan. His friends were just about to go to the Richmond meeting of the National Board of Trade; there they met William Hopper and John A. Gano. These merchants of Cincinnati found that they had the same idea as H. E. Paine of Milwaukee, *i.e.*, that the Federal Government should develop the Cincinnati enterprise and make it useful to the whole country. The National Board of Trade indorsed this idea, Prof. Lapham of Milwaukee drew up some statistics of storms and destructions on the Lakes, the Hon. Halbert E. Paine prepared a bill; we each put our shoulders to the wheel, and behold, on February 9, 1870, the Secretary of War was authorized to carry out this new duty. I had spent a year in finding stations, voluntary observers and telegraph facilities; every old classmate or friend of progressive meteorology had helped the new idea.

The work had now, as I supposed, passed out of my hands, but there was in reality much more for me to do. A letter from the Chief Signal Officer, U. S. A., General Albert J. Myer, asked for all possible coöperation. The officials of the Western Union Telegraph Co. offered the Observatory the same free daily weather reports that they had for twenty years been giving to the Smithsonian Institution and the daily press; so I continued temporarily to make and publish the Cincinnati Bulletin, but in a much simpler form and without forecasts. This continued until May 10, 1870, when I was married, and the preparation of the midnight bulletin passed over to the officials of the local telegraph office. It was continued in this shape until November, 1870, when the tri-daily bulletins of the Army Signal Service began. With the help of Mr. Williams, who was in charge of the Western Union office, I printed in October, 1869, a code of cipher, and should have used this code for economy had not the law of February 9, 1870, rendered further reports by our stations unnecessary. This code was subsequently greatly improved by the Weather Bureau men, and particularly by Gen. A. W. Greely, and it is still in use.

The manifold duplicate copies and the printed copies of the daily Cincinnati Observatory Bulletin were distributed until the Chamber of Commerce no longer needed to support it, then Mr. Williams devised a simple form of manifold map that was a great improvement on my original tabular form of daily reports. This map was soon adopted by the Signal Service, but was itself displaced in turn by the present handsome daily lithographed chart. Without the help of Armstrong and Williams and the new manifold method we could not have promptly responded to the needs of our friends. By November, 1870, I had gone to New York and prepared to go as astronomer on one of the Panama Canal surveys, but I gave this up and should have returned soon to Cincinnati had I not, in December, received a letter from General Myer stating that he wished to see me. My work with him in the Weather Bureau of the Army Signal Service began January 3, 1871. After a month's practice it was decided that my forecast would evidently more than fill the popular expectations, and tri-daily publications began at once. The term "probabilities" then became official, as it had begun in October, 1869, and in those days it was appropriate; but we have long since substituted the word "forecast."

The subsequent development of the service under Generals Myer, Hazen, Greely, and Professors Harrington, Moore and Marvin, may be gathered from their special or annual reports. The service has been greatly favored by the hearty coöperation of many men of knowledge, skill and enthusiasm.



The 14-inch, 45-caliber naval gun, mounted on the New York, Texas, Nevada and Oklahoma

The Size of Naval Guns

Are Twelve 14-Inch or Eight 17-Inch Guns to Be Preferred?

By Lieut. (J. G.) Richmond K. Turner, U. S. Navy

At the beginning of the present war England was the only power possessing naval guns as large as 15 inches, the largest calibers mounted by other nations being either 12 or 14 inches. We now hear that Germany is building 17-inch guns, that England has 17- and even 18-inch guns under construction, and that the United States may abandon the 14-inch in favor of the 16-inch. The question has been raised as to why this country, having built a 16-inch gun some years ago, did not immediately adopt it and discard the 14-inch in order to keep ahead of foreign construction, the assumption being that the largest and most powerful gun must necessarily be the most effective.

In an analysis of a subject such as that of effective gunnery we must reject all features that are based on chance and hold to those that will apply in the greater number of cases according to the laws of probability and error. For instance, last year, after the second North Sea fight, it was very frequently asserted, because the range was very great and one of the few effective hits on the English vessels was in one of the *Lion's* machinery compartments, that the range for modern battle had become so great that no shell could hope to penetrate side armor, that therefore the hit in question must have been a "plunging" or falling hit through the protective deck, and that therefore plunging hits were the only ones that could now be effective. Opponents of heavy armor protection also seized upon the situation and said that since ranges were now to be so great, we may as well discard or greatly reduce our armor! The fact is that there are no better reasons for either assertion than before this battle occurred, and the reasons that previous to the war dictated the use of guns and armor of a certain character seem to apply equally well now—though this does not mean that we should not take advantage of certain *known* truths, such as the increased range to be expected and the *possibility* of chance hits such as that on the *Lion*.

Therefore in what follows attention will be called to the *most probable* events in a naval battle and less attention devoted to merely *possible* happenings. And obviously, we must leave out the question of training, because that is one of personnel, and we must confine ourselves to material only.

Most of the sound arguments advanced for or against an increase in the caliber of naval guns may be grouped under four general heads:

1. The number of guns that may be carried.
2. The relative destructive effect of two shells of different calibers.
3. The number of hits that may be made with two different batteries in the same interval of time.
4. The "life" of a gun, or the number of rounds it may fire before losing its accuracy.

A ship's effectiveness of gun fire is measured by its capability of destroying another ship while suffering the minimum damage herself: in other words, by the destructiveness of her fire relative to that of the other ship.

Suppose we are building two ships of equal size, speed, and armor protection, and on one we intend to mount 17-inch guns and on the other 14-inch guns. Obviously, since the same weight in both ships is to be allowed for ordnance purposes, we can not carry as many of the larger guns as of the smaller. Thus if we put four 3-gun 14-inch turrets on one ship we will probably be content with four 2-gun 17-inch turrets on the other. This is about the ratio of light to heavy guns usually admitted in discussions as to the relative advantages of two different batteries. We may say then, in general, that if we choose light guns instead of heavy we may have about 50 per cent more of them.

Comparison of the 14-inch and 5-inch projectiles

In examining the destructive effect of armor-piercing shell against a ship it is apparent that we can put the enemy ship effectively out of action by sinking her or by so disabling her crew and propulsive machinery that our torpedo vessels may sink her. In both cases the same result is attained: that is, she is destroyed whether we sink her by means of shot holes in her hull below the water line or send so many explosive shells into her machinery compartments from above the water line that she is forced to fall to the rear. In the one case destruction is caused by the direct piercing effect of the projectiles and in the other by their explosive effect.

It is immediately apparent that there can be little difference between the holes caused by 14-inch and 17-inch projectiles, because in either case so much water is admitted that it would require but few such holes to sink the ship. Therefore, from this standpoint there is a distinct advantage in having the greater number of smaller projectiles, provided they penetrate the hull.

If we examine the explosive effect of the two shells the same advantage holds to a certain extent. A 14-inch shell weighs but 1,400 pounds and a 17-inch about 2,500 pounds, but the effects of their explosion in a ship's compartment are much the same. The high order burst of even a 14-inch shell is so terrible, the increase in pressure being so great and the fragments so numerous, that it is inconceivable that any machinery or human beings in the compartment could escape destruction. In other words the 14-inch shell will so effectively put a whole compartment out of commission that there is little use for the extra effect that would result from the explosion of a larger shell. If a 17-inch shell strikes a turret it is more likely to disable it than is a 14-inch, and its effect is decidedly more destructive than the 14-inch when it bursts on the open deck or against the upperworks of the vessel. It is only by penetrating hits below the water line or bursts in the machinery compartments that a ship is put completely *hors de combat*, however, so it must be admitted that it is probable that the destructive effect of a salvo of twelve 14-inch shells is, with equal

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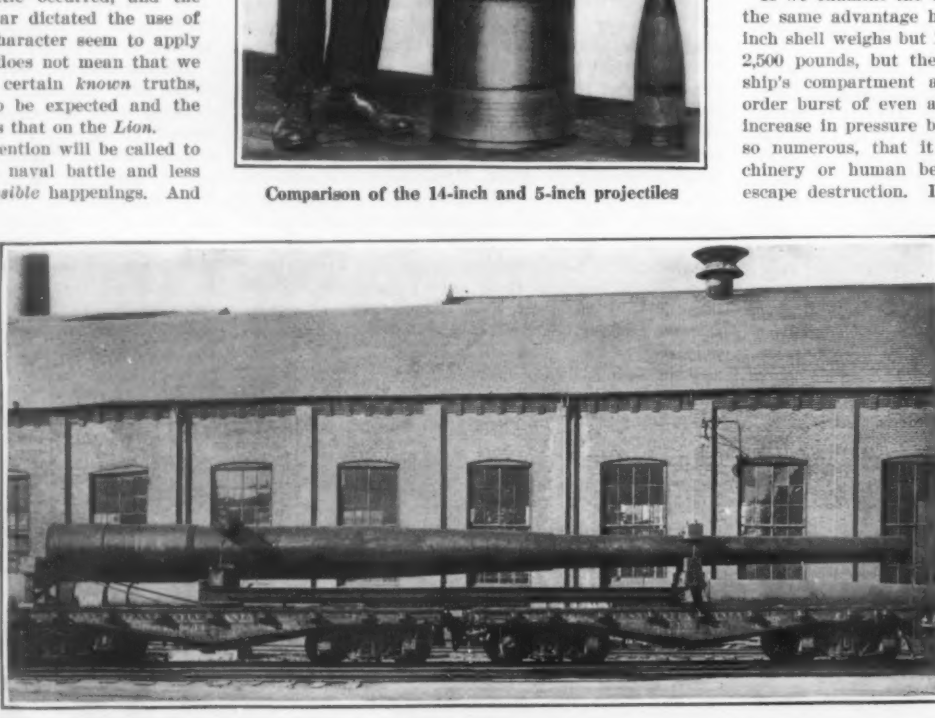


The new 14-inch, 50-caliber gun, to be mounted on the dreadnoughts now under construction

Modernizing Mississippi River Transportation

The New Steel Barges Which Usher in the Revival of Traffic on the Great Inland Waterway

IN the revival of the Mississippi River as an important artery of commerce many contributing factors are to be found, among them the improvement of the waterway by the removal of dangerous shoals, rapids and other natural obstacles, as well as the improvement of dockage facilities by many of the municipalities which border on the banks of the great river. We read but a short while ago in these columns of the huge sums of money which are being expended in re-creating the Mississippi River as a great commercial highway.

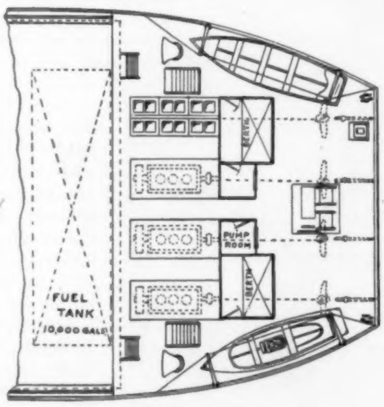
But improvement of waterway and dockage facilities does not constitute all that is necessary in the revival of the river traffic. Times have progressed; while the characteristic Mississippi steamboats served their purpose well before the network of railways became so dense in the middle west, they are, for certain classes of transportation, inadequate for current requirements. Hence the introduction of oil-engine driven steel barges is in itself perhaps the paramount contribution toward the restoration of Mississippi River traffic.

The perfection of the modern internal combustion engine, which already has served satisfactorily in coastwise and ocean propulsion of vessels, is strikingly brought out by its advent on our inland waterways in the new Mississippi River freight barges the first of which began running between St. Louis and New Orleans on April 15th. This modern and unique freighter, the first of an ever-increasing fleet, is 240 feet long, 43 feet wide and capable of carrying a cargo of about 2,000 tons dead weight. The latter is stowed in a structure 200 feet long, 40 feet wide and 12 feet high, entirely above and distinctly separate from the hull proper.

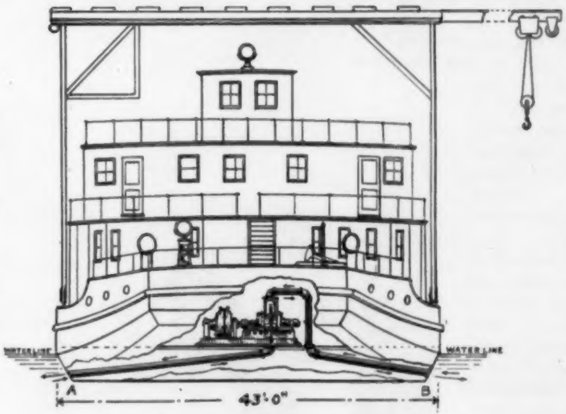
The cargo of the new steel barge is handled through the agency of an electrically-operated traveling gantry crane which can travel the entire distance of the cargo-stowing space. The crane has an extension boom that may be projected 68 feet on either side of the barge. The lifting capacity of the crane is three tons. The roof of the cargo space is so arranged in hatches that any or all of the roof can be removed, thus facilitating the loading or discharging of freight. The cargo space is also fitted with sliding side doors.

In general construction the vessel is absolutely fireproof; and the hull proper, being rendered additionally water- and air-tight through the subdivision of the main hull into four compartments any one of which may be

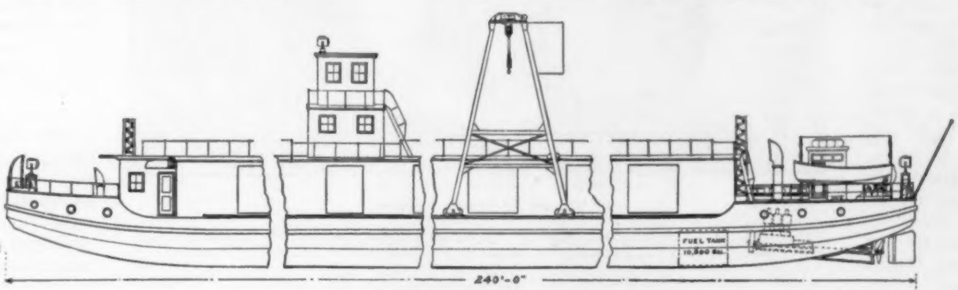
One of the large steel barges being built for the transportation of freight between inland cities on the Mississippi River and its tributaries



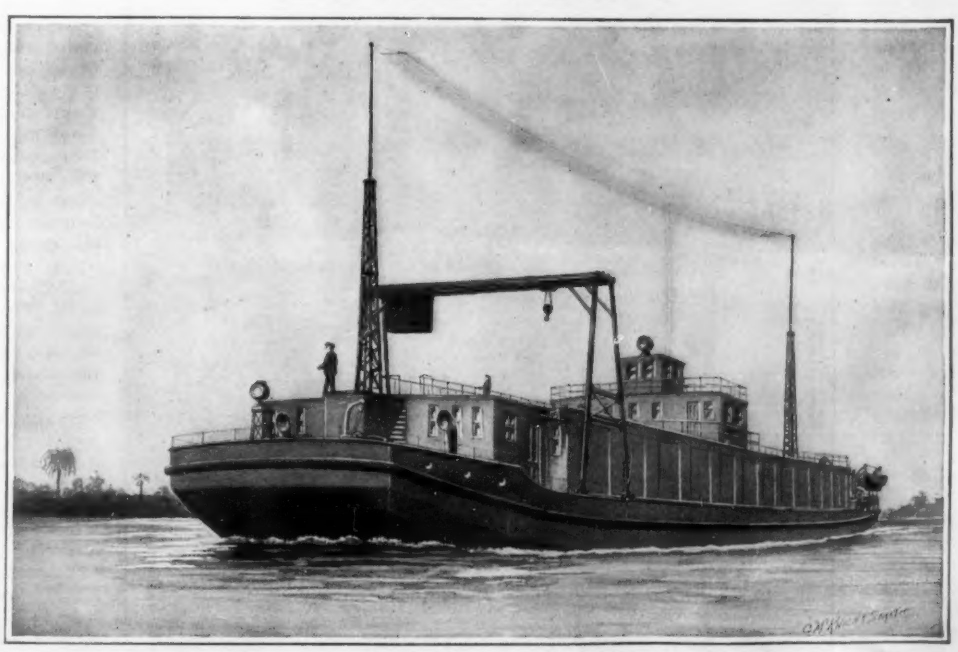
The stern of the barge, showing the location of crew's quarters and engine room



The bow of the barge, showing the arrangement of the traveling crane as well as that of the bow pump



Elevation of the Mississippi River steel barge



Mississippi steel barge plying the great waterway between St. Louis and New Orleans, with stops at important intermediate points

punctured below the waterline without very serious damage, renders extremely remote the chances of foundering. But should unforeseen accidents cause leakage in the hull, powerful electric bilge pumps capable of discharging 8,000 gallons per minute are installed on board and can be operated at an instant's notice by a switch located in the pilot house. While dwelling on the features of the hull it is well to point out to the fact that since space above the deck is provided for the stowing of the cargo, the liability of the merchandise to damage in case of leaks is reduced to a minimum. Further, the longitudinal trusses and the transverse bulkheads, which are rendered possible on an extensive scale, give the hull a strength and stiffness far beyond that of ordinary river craft.

Forward of the water-tight compartments in the main hull are located the chain lockers, storerooms, and the crew's sleeping quarters, while the extreme after end of the hull proper is given over to the engines and other mechanical installations. The engines, four in number, are rated at 80 horse-power each and drive four screws of 51-inch diameter, giving the barge a speed of 10 miles per hour in still water, 7 miles per hour against the current and 12 miles per hour running with the current or downstream. The engines burn a petroleum distillate of 29 deg. Beaumé gravity. The fuel-tank capacity is 10,000 gallons.

Numerous unique ideas are disclosed in the various installations of mechanical devices, prominent among which is the bow pump with suction and discharge at port and starboard. The pump is electrically driven and by the turning of a switch in the pilot house it can be made to take in water at either side and discharge it at the other as an 8-inch stream, resulting in a pull of 25 horse-power. It is said that this force is sufficient to enable the vessel to be turned against a 40-mile wind. A system of tell-tale dials is also installed by which the captain of the barge is constantly informed as to exactly how much water he is drawing and other mechanical conditions which are prevailing in any part of the vessel.

As will be seen in the illustrations, the pilot house and officers' quarters are located above the main cargo house amidships. The number of the crew is reported to be 14 men all told, made up of captain, mate, two engineers, two oilers, cook, two wireless operators, four deck hands and cabin boy.

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War Game—X

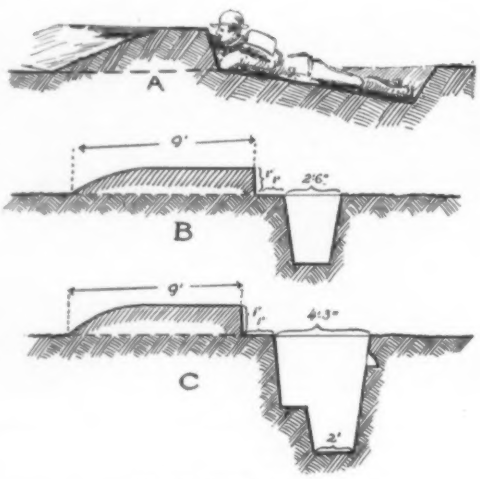
The Trenches—Use of Pick and Spade in Modern Warfare

By Lieut. Guido von Horvath

TRENCH warfare is the outcome of extended battle lines. It aims at disposing of the possibility of enveloping movements. It is evident that the methods of trench fighting must be different from the battle fought in the open field and its requirements are of quite primitive nature.

The spade and the pick-ax become more important than the cavalry sabre; the defense depends more on good obstacles than on the possibility of skillful maneuvering. The fighting lines approach each other in trench warfare more closely than could have been imagined in any style of fighting since the invention of gunpowder.

In place of the free movements of the battle lines in the open and the quick decisions, comes the prolonged struggle of men-worms. The field of operations might seem to the eye an empty, desolate ground. The rattle of the smokeless rifle and the whistle of the bullets would seem to be a strange show, were it not for the thunder of guns of all calibres. The exploding shells, the bursting of shrapnel over a seemingly waste field, are the characteristics of the gigantic fights of this type.



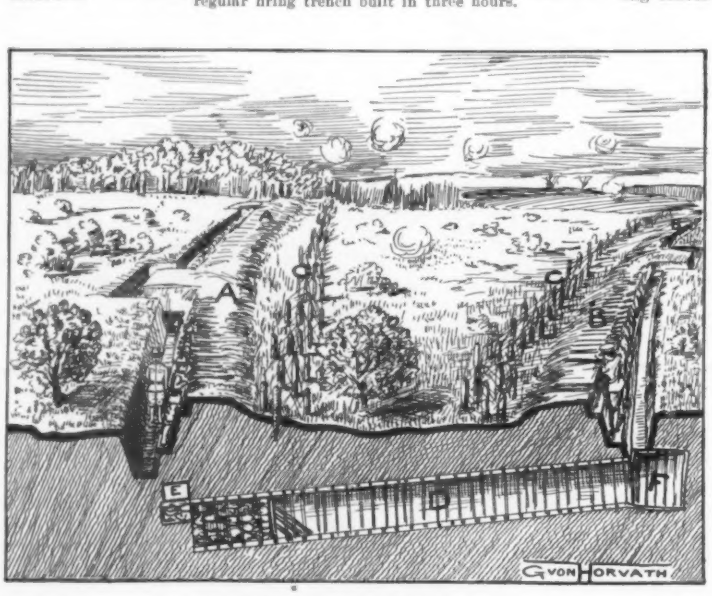
Various types of trenches

A. Hastily built trench ready in twenty-five minutes. *B.* Regular firing trench built in an hour and a half. *C.* Improved regular firing trench built in three hours.

Such a fight on a small scale can only develop in a case where, on both flanks, the natural obstacles against an enveloping attack are unsurmountable. We have seen such a case in the Ninth War Game, where the Red forces, through the inundation of a large territory, secured their right flank, while the left is protected by Red forces across the Nehaminy River.

War Game IX pictured the making of the trenches, the hasty preparation of the defensive lines to hold back superior forces. Now we assume that the Red forces have successfully withstood the attack of the Blues, but they have not been in a position to undertake a sufficiently strong counter attack to turn their passive gain into an active one.

The result of this action must be that the Blues will be forced to entrench on the ground where they find themselves, probably under the fire of the enemy. Nevertheless, they must do this, unless they are willing to accept the inability to break through the Red line as a defeat. Very likely the cover of the night will aid the Blue forces in their work of entrenching. But whatever happens, the entrenchments must follow, once an engagement has proven that the direct attack against an entrenched position did not have the force, the "punch," behind it sufficient to crush the enemy.



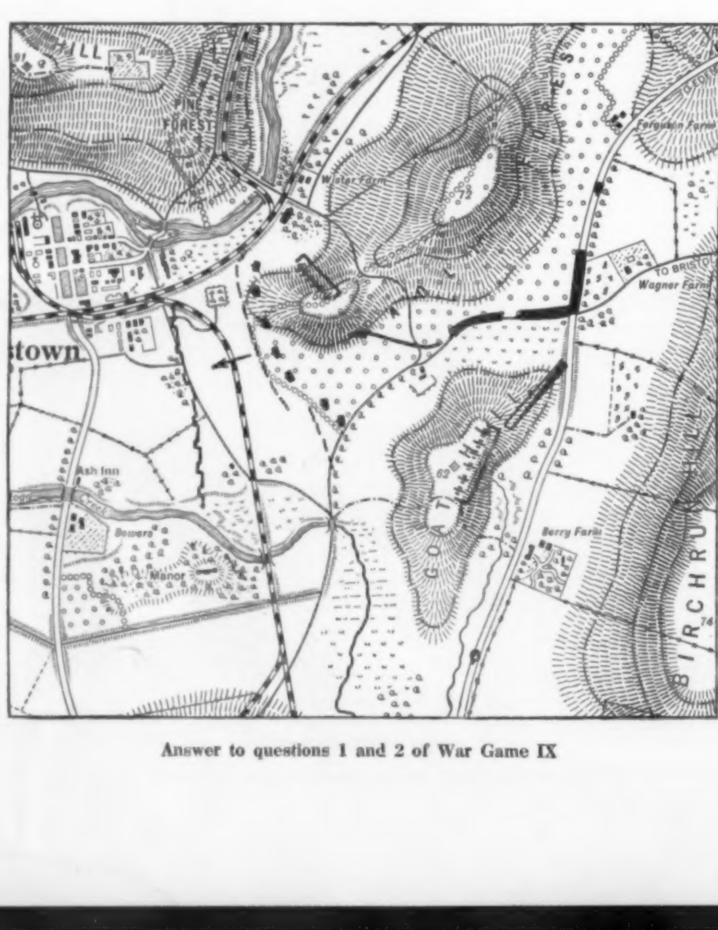
Theory of trench warfare

A. Red trenches. *B.* Blue trenches. *C.* Barbed wire entanglements. *D.* Tunnel leading to enemy trench. *E.* Explosive in mine. *F.* Chamber whence sapping was started.

The character of the entrenchments depends upon the ground on which the troops may make their stand. But, even on difficult ground, the night following the first attempt will give ample time to build trenches of satisfactory strength to give protection to the forces in the firing line.

We observed, in War Game IX, these trenches in the making. Now the Blue forces will have to do a very similar work. The main difference between the construction of the two lines of trenches will be that the Reds enjoyed a time of peaceful preparation, while the Blues must work under fire. It is easy to realize that this last task is quite a difficult one.

Trench warfare has grown in importance since the Russo-Japanese war, and to-day is far more important than ever before. Therefore, it is necessary that we become acquainted with its nature.



Answer to questions 1 and 2 of War Game IX

Construction of Trenches Under Fire

To have a concrete case before us, we shall use the situation of the Blue and Red forces on June 14th, 19—, in the engagement south of Pottstown.

Some time around 1:00 P.M., the advance guard of the Blue detachment deployed on the western edge of Pauly Forest and opened fire on the Reds. The targets offered by the well sheltered Reds are rather small and unsatisfactory, promising little damage at the distance. Therefore, the best means to improve the fire effect would be a rapid advance on the part of the Blues. Now, while time is being gained for the main body of the Blue detachment to reach the deploying point and to make ready to assist the advance, the Red artillery will make it hot for the leading elements of the Blues, unless the Blue artillery is able to attract all the attention for the time.

In other words, while the infantry is getting into position and preparing for the advance, there will be an artillery duel fought, provided the artillery of the entrenched defenders is discovered early enough in the game to offer a target. Otherwise, the attacking party must turn its artillery on the firing and the reserve trenches.

We shall assume that, at 2:00 P.M., the Blues are in a position to undertake the advance against the Red position. Blues, being stronger, will very likely advance on an extended line, with the intention of producing a converging fire effect on the point where the general assault might be expected to penetrate the enemy's lines. The Blues will also occupy such flanking positions as will enable them to assist the attacking center portion of the line, by fire of position until the very last moment.

The Blue line commences to advance, and has scarcely covered the first few yards of the effective zone of Red fire when the losses begin to grow appalling. Let us assume that the Blues are at a distance of 1,000 yards from the Red position, when the first local commander orders his company to use the entrenching tools after the next rush. Then the following things are going to happen:

The skirmish line makes a quick rush of about 100 yards forward; the portions of the line to the right and to the left increase the rate of their fire, while the leading company take to their spades, and, lying flat on the ground, each man constructs a shelter for himself as quickly as possible. The process is simple; each man throws the dirt forward as he digs himself in. In thirty minutes or less there should be a series of satisfactory trenches to shelter individuals lying prone.

One firing unit after another will thus dig itself in, and after this is done the progress of the fight will assume an altogether different aspect. In the place of rapid action a new sort of conflict, resembling siege operations, will develop, until both forces have gathered new strength and energy to undertake a new offensive.

We have assumed that the Reds have remained inactive and have been contented with simply holding off the Blues. Otherwise a counter attack might have produced an entirely different situation. Therefore, the first energetic advance of the Blues came to a standstill. While the opposing artillery are working against the most exposed trenches, and very likely against the enemy artillery, the infantry fire will slacken, and will consist chiefly of firing upon single targets when available.

The night will be a busy one for the Blues, for unless they feel sufficiently strong to make a new attempt to rush the Red trenches, they must strengthen their own positions and prepare obstacles against a possible advance on the part of the Reds. But even in case of an expected second Blue advance, it will be found advisable to prepare the trenches, as in case of a reverse they will be of great value as a rallying point, and will give an opportunity to reform and reorganize.

The more and the better obstacles are placed before the trenches, the easier will it be to defend them. The most effective obstacles are those which cannot be seen at a hundred yards' distance. A thin hedge, for instance, which permits the

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Emphasizing the Theme in a Player Piano

THE first successful mechanical piano players had no sooner made their appearance than there was an immediate demand, at least on the part of those who possessed the so-called musical ear, for some means of playing the solo, melody, or theme with a stronger emphasis than the accompaniment. Most of us who own or have owned piano players (and this is particularly true in cases where the operator had never learned to play by hand) will remember how the first delight at hearing a musical composition being played directly under one's own control, was quickly followed by a desire to subdue the accompaniment and bring out with clearer emphasis the theme or melody. The inability, in the early players, to emphasize the theme was due to the fact that a uniform tension was used for all the operating pneumatics throughout the scale.

There is probably no element in the player that has been made the subject of so much patient investigation and clever invention as that of theme or solo expression, and, during the past decade, some very ingenious devices have been tried out and placed upon the market with more or less gratifying results.

Broadly speaking, there are four classes of theme-expression devices. In one of the earliest of these, an attempt is made to emphasize the theme by dividing the scale into sections, in each of which the tension of the player-pneumatics is regulated by their own control valves. In this type, the operator endeavors to throw increased tension into that particular section or zone in which the theme notes occur. The obvious defect of the arrangement is that not only the theme notes in any particular section will be emphasized, but also such notes of the accompaniment as also happen to lie in that section.

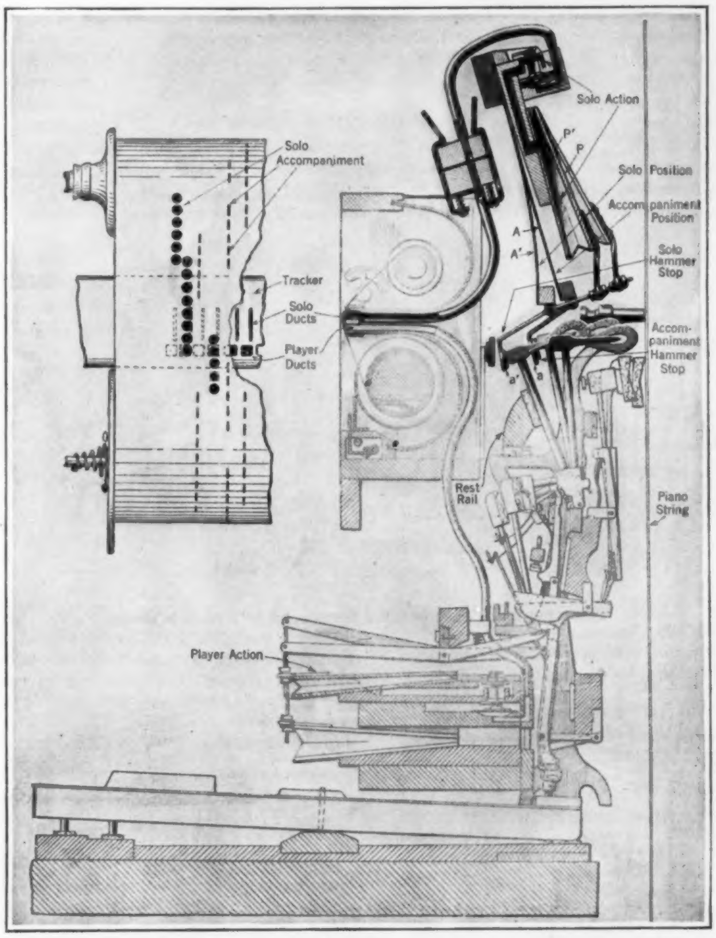
Another type of player is provided with two separate sets of pneumatic actions, each operated by its own tracker-bar range; one being used for the melody and the other for the accompaniment notes. If this were carried out literally, there would be a call for a tracker-bar with 88 melody notes and 88 notes for the accompaniment; but the difficulty of having a bar and music roll of this length led to the adoption of a bar containing only about 120 apertures.

One of the best known and most successful melody playing pianos secures the desired effect by cutting the perforations in the music roll so that the accompaniment notes are struck first under the normal air tension, and then the air tension is increased in the slight interval before the melody note is struck. The admission of the high tension before the sounding of the melody note is done automatically by means of perforations on the edge of the music sheet.

It will be noticed in the three systems above mentioned that the emphasizing of the melody is accomplished through automatic means for increasing the air tension under which the melody notes are struck.

In the player piano illustrated in the accompanying drawings, the novel features of which have been patented by Mr. Paul Brown Klugh, of Chicago, Ill., the accentuation of the theme or solo is accomplished by controlling the length of stroke of the hammers. The way in which this is done will be understood by a study of the drawings in which the player mechanism is shown in a light tint and the solo mechanism in a darker tint.

The solo action is arranged in the upper portion of the piano case and extends throughout the full length of the hammer scale. Back of the hammers is arranged a series of adjustable hammer stops, there being a stop to each adjoining pair of hammers. The position of these stops, that is to say the distance between them and the piano strings, is governed by the action of the solo pneumatics P, P' and a series of springs A, A'. When the operator is pumping, the solo pneumatics are normally inflated, as shown at P, and the springs A and the hammer stops a are in the positions shown in the drawing. When a solo note is to be struck, the pneumatic is deflated, as shown at P'; the corresponding spring is sprung back into the position A' and the hammer stop to which spring is connected is thrown back into the position of full stroke, as shown at a'. The effect of this arrangement is that the hammers corresponding to the accompaniment notes travel, relatively, a short distance before they strike the strings, and the whole accompaniment is played with soft tonal effects; but the hammers which sound the theme or solo notes, traveling through a greater distance, strike their respective strings with greater force and with much louder resulting tone.



Mechanism for intensifying the theme in a player piano

The operation of the solo action is controlled automatically through the music sheet and tracker bar. The tracker bar is provided with the usual apertures, spaced to register with the note perforations of any standard music sheet. The tracker bar is also provided with apertures in the shape of narrow slots, one above the end of each player aperture, as shown. The larger player ducts or apertures open into a series of tubes which lead down to the player action, and the slotted solo ducts are connected to tubes which lead up to the solo action.

The music sheet differs from the standard music sheet by having note perforations which differ from each other, and as the sheet travels over the tracker bar certain note perforations (those for the accompaniment) register only with the large player ducts and others (those for the solo) being wider, register with both player and solo ducts.

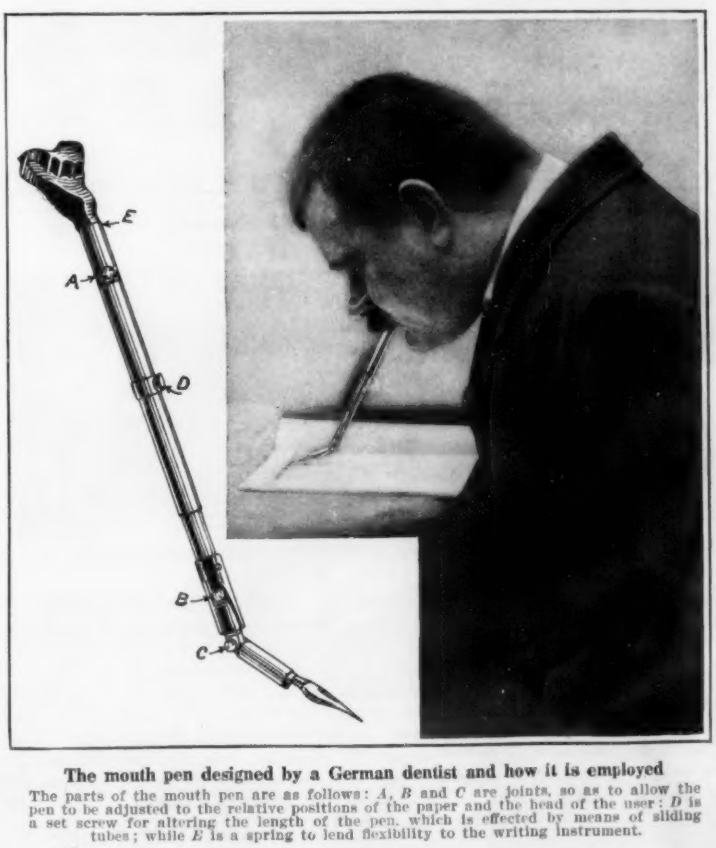
Now as the music sheet travels over the tracker, each accompaniment perforation will pass to the side of the slotted solo apertures in the tracker and will pass over the regular player or accompaniment apertures, and each of the solo perforations will pass over both the slotted solo and the regular player or accompaniment apertures; but when the solo perforations pass over their respective solo apertures in the tracker, they will deflate their respective pneumatics, throwing the respective hammer stops back, and, by increasing the length of stroke of the hammers, will cause said solo notes to be struck with greater force and with resulting louder tonal effects.

Furthermore, in addition to this automatic selection and emphasizing of the solo, the tonal power of the notes may be varied by varying the vigor of the pumping and thus changing the air-pressure in the player action. Again the degree to which the solo notes are emphasized may be varied by varying relatively the short-stroke and long-stroke positions of the hammers.

A Pen that Permits of Writing with the Mouth

By Dr. Alfred Gradenwitz

ADVANCING civilization has entrusted our mouth—originally a merely vegetative organ serving for the introduction of food—with functions of growing complexity. While no longer an offensive or defensive weapon, it has thus become the organ of speech and interpreter of love. The present war, which not only kills but mutilates, puts before it another, most charitable, task: enabling those poor cripples who have lost their hands, to put down their thoughts in writing and thus communicate with their friends and fulfill their professional duties as before.



The mouth pen designed by a German dentist and how it is employed

The parts of the mouth pen are as follows: A, B and C are joints, so as to allow the pen to be adjusted to the relative positions of the paper and the head of the user: D is a set screw for altering the length of the pen, which is effected by means of sliding tubes; while E is a spring to lend flexibility to the writing instrument.

The left hand, of course, readily assumes such functions as the right one is no longer able to perform, and there are cases on record of persons who, after losing their hands, gained wonderful skill with their feet. These cases, however, are the exception rather than the rule, while the simple attachment about to be described endows the mouth, even under the least favorable circumstances, with remarkable dexterity in operating the writing pen. In fact, the special case that suggested the construction of this device was, for different reasons, especially unfavorable. It was not, indeed, a case of an invalid soldier but that of a workman who, at the age of 38, without any apparent cause, was attacked by growing paralysis of both arms, attended with increasing atrophy of the muscles. The late Prof. Joachimsthal, of Berlin, a distinguished orthopedist, induced a dentist, Mr. J. Grünberg, to take charge of his unlucky patient and to design for him some suitable writing apparatus.

Since the patient had himself tried in vain to write by means of a pencil introduced between his teeth, the dentist followed up this suggestion, setting himself to design some suitable mouth-piece. As the patient possessed a remarkably strong set of teeth, the six incisors could be used exclusively to support the penholder. The mouth-piece, moulded in accordance with the interior of the mouth, embraces about

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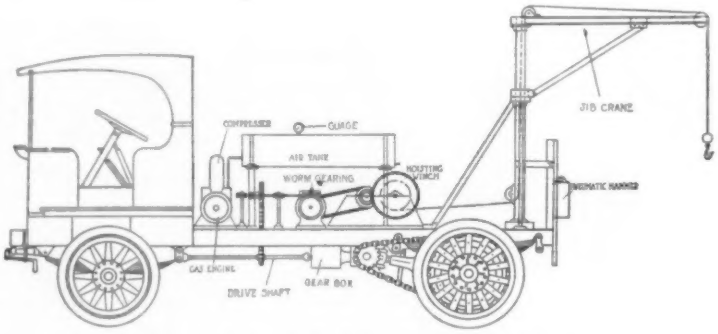
The Motor-driven Commercial Vehicle

Conducted by VICTOR W. PAGE, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any questions relating to mechanical features, operation and management of commercial motor vehicles

Special Truck for Circus Use

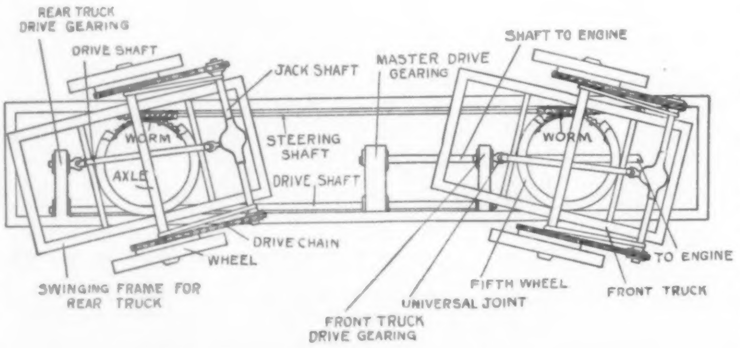
A SPECIAL truck has been contrived to replace or rather relieve the elephants and horses of the circus from the duties of hauling the cage wagons for the animals and perform all of the heavy jobs incidental to the loading and unloading of the mass of paraphernalia necessary to properly present the modern tent show. It also materially helps the canvas men in dragging and setting up tents and driving tent stakes. The design is the result of the combined efforts of the manager of a Wild West show and a practical truck man. The chassis is of three tons capacity. All of the devices are carried on the frame in place of the ordinary body and are located back of the cab. The main elements are a hoisting winch, a jib crane and a pneumatic stake driving arrangement. The hoisting winch is operated from the drive shaft joining the clutch to the gear box by means of a chain to a countershaft. This carries a worm and worm gear speed reduction mechanism. Another chain connects the speed reducing gear to the hoisting winch driving sprocket and gearing. A separate, small gasoline motor and air compressor is placed directly in back of the driver's cab and supplies air to a large storage tank which is carried in a horizontal position above the frame. The air from the tank is used to operate the stake driver. The reason a separate engine is used to drive the air compressor is that it permits a stake driving mechanism to be operated independently of the truck power plant and of course is an economy because less fuel is consumed in doing the work. It will be evident that the winch can be used for either drawing the heavy wagons up the skids to the freight cars, or it can be used in connection with the unloading process. The pneumatic hammer materially shortens the time required to drive stakes while these can be easily removed by simply attaching the hook of the jib crane to the stake and turning the power onto the winch. This is an interesting example of one of the many uses to which the motor truck is adapted.



Three-ton truck chassis fitted for special service in a circus

New Four-Wheel Drive Design

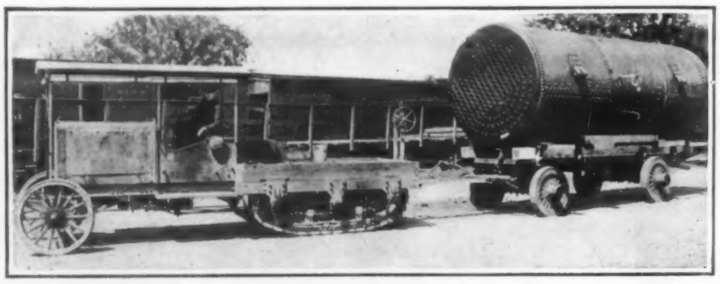
A RECENTLY devised arrangement that permits of driving and steering by all wheels is shown in the accompanying diagram. The practical nature of the service rendered by the four-wheel drive trucks under the severe conditions of war service both in this country and Europe has stimulated invention along this line. In this assembly both ends of the truck are exactly alike as far as relates to the driving arrangement. The wheels, axles, supporting springs and the jack shafts used to drive the wheels are carried by independent auxiliary frame members which are attached to the main chassis by ball bearing fifth wheels. A steering shaft is supported by one of the frame members, this carrying a right hand worm on one end and a left hand worm on the other which mesh with corresponding members attached to the portion of the fifth wheel fastened to the wheel and frame assembly. It will be apparent that as the shaft is rotated that the worm gearing will tend to swing the wheels around so that they assume the proper position for negotiating the curves. The drive is through the medium of a long shaft carried by one of the frame members, this being connected to the propeller shafts by means of silent chain gearing. The jack shaft follows conventional design and drives the wheels which revolve on fixed axles. A differential gear is provided on each jack shaft, and a third compensating gear is provided in the master gear box at the center of the frame to allow for the difference in travel between the front and rear trucks when going over uneven roads. Eight hub brakes are provided, four internal and four acting on the outside of the drums. Radius rods are provided to take the driving stresses while the torque is resisted by the springs. In other respects this truck follows conventional practice though the method of final drive is radically different from anything that has yet been offered.



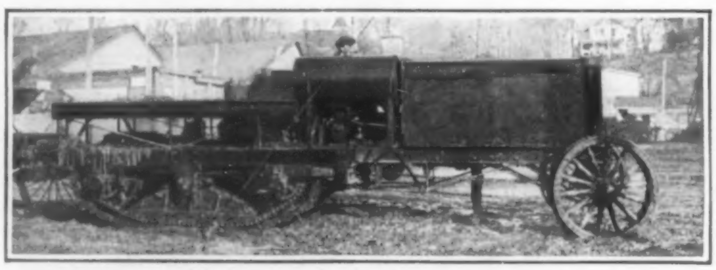
Distinctive four-wheel drive and steer truck arrangement

Track-Laying Truck-Tractor

A TRUCK-TRACTOR using driving members operating on the track-laying principle which has been extensively tried out in New England lumber camps for hauling logs has been found useful for other heavy hauling work. The machine is a distinctive construction, inasmuch as it will carry a large load as well as provide sufficient draw bar pull for hauling a heavily loaded train of trailers. The machine has almost as much speed as a heavy truck, but in addition has the large drawbar pull of a tractor. It will carry five tons on its own load platform. It has three forward speeds, respectively two, four and six miles per hour and reverse. The machine is made in two sizes, a 60 horse-power, which is depicted in the upper illustration, and one of 100 horse-power as shown below it. In a recent demonstration it is said that six trailers weighing 2,800 pounds each, on which 33 tons of scrap iron was loaded, were taken up a 16 per cent grade and that the entire load could be started from a standstill on this gradient, making a pull of 41 tons for the machine in addition to its moving its own weight. Trucks that have been built for the English government have averaged 7½ miles per hour, though it is stated that the six-mile speed is plenty fast enough for heavy duty work, as this is about the limit at which heavily loaded trailers can travel over the average country road. A strong claim is freedom from tire trouble, as it is said that the treads will last three years with ordinary usage. The tread is a patented construction that makes oiling any of the working parts of the tractive member unnecessary. This is said to be a point that is exclusive in this machine. This type of tractor has been used successfully in hauling heavy artillery, for which work it is particularly suited owing to its great tractive power.



Continuous tread-tractor hauling a heavy load



Truck-tractor with track-laying or continuous tread-traction members

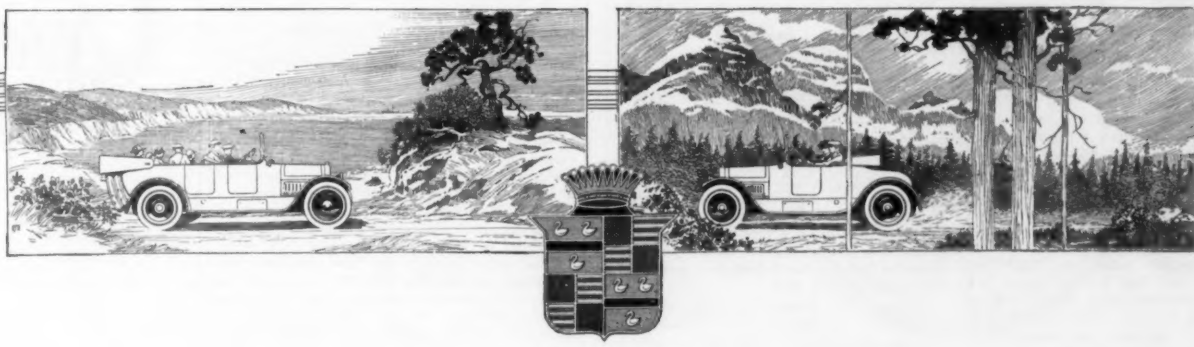
Motor Queries and Answers

F. R. M. writes: Will you explain the exact status of kerosene carburetion and inform us if the ordinary forms of carbureters can be changed over to use the cheaper fuel. The rapidly increasing cost of gasoline has materially increased our operating expenses and we are thinking of changing over to the more plentiful fuel.

Ans. It is not possible to use kerosene successfully in a vaporizer that has been designed for use with the more volatile gasoline. A kerosene carbureter must be designed especially with the requirements of this fuel in mind in order to provide means of facilitating sufficiently rapid evaporation to enable the engine to run successfully. Kerosene carbureters are on the market which are said to be practical, though there are a number of practical difficulties that are actual drawbacks to the wide adoption of kerosene. It is very difficult to start an engine on kerosene vapor unless some means of preheating the engine and carbureter are provided. The usual practice is to start the engine on gasoline and only turn on the kerosene when the parts have become heated.

J. K. J. writes: Will you please explain why it is necessary to have a different degree of angularity in the V-engines of 8- and 12-cylinders?

Ans. The cylinders of an 8-cylinder engine are 90 deg. apart or 45 deg. each side of the engine center line. Those of a 12-cylinder engine are 60 deg. apart. The reason for this is that in a four-cycle engine an explosion can be obtained in each cylinder only every second revolution. The piston has to move up and down twice for each explosion. The crankshaft has to make two turns to receive a power impulse from any given cylinder. In an 8-cylinder engine four explosions per revolution would be obtained and inasmuch as a revolution means covering 360 deg. it is apparent that in an 8-cylinder there will be a power impulse every 90 deg. of crankshaft rotation. In the V-type motors the explosions alternate from one side to the other. For example, cylinder No. 1 on the right hand block would be followed by cylinder No. 1 on the left hand block. As the crankshaft can travel only 90 deg. between impulses in order for the pistons to be at the proper point to receive the impact of the explosion, it is necessary for the cylinder center lines to be just 90 deg. apart. In a 12-cylinder V-motor the explosions occur 60 deg. apart as there are six for each revolution of the crankshaft. It is necessary therefore to space the cylinders 60 deg. apart. A simple rule that can be easily remembered for determining the angle between the cylinder blocks is to divide 360 deg. by half the number of cylinders.



T O U R I N G

In The Eight-Cylinder Cadillac Holds New Fascinations

ONE of the greatest boons which the Eight-Cylinder Cadillac confers upon motorists is, that it removes the strain and the weariness from long distance motor travel.

Men and women all over the world are awakening to this delightful discovery.

The roads of the continent are calling to them with a new charm and a new insistence.

The Cadillac "Eight" has supplied the last necessary link in the chain of causes which constitute the thing called luxury.

It sets the traveler free from taut nerves, from tense muscles, and from constant concentration on the performance of the car.

All the glorious tingle of a noiseless flight through space is there in increased measure.

But the strain is gone—gone and forgotten, because the flow of power is so continuous, so smooth, so flexible and so quiet that you are scarcely conscious that the engine exists.

There are no convulsive movements of the motor, no noise of straining and labor, no irritating vibration.

You relax and rest, in the Cadillac, because the unpleasant reminders of effort and labor are removed.

You forget the engine, you forget the mechanical system which is carrying you forward. You luxuriate in a sense of serene well-being and comfort.

Your mind is released from its thraldom to the car, and turns a thousand times more often to the beauty of the road, of the sky and of the landscape.

The joy of touring is not only a greater joy in the Cadillac, but it calls into being a new set of physical and mental sensations.

Heretofore, no matter how gallantly your car mounted a hill, you were conscious every moment that it was climbing—that it was laboring.

Now you know that the hill was high, only because you saw it before the mount began—or looked back after the crest was reached.

You travel almost continuously on high gear—under throttle control.

The power-application is so fluid that, when you accelerate the speed, the effect is very much as though you had "turned on" the power, as you "turn on" water by opening a spigot.

As for sound and vibration, the engine scarcely seems to be energizing at all.

The car simply glides from one rate of travel to another, without apparent effort or hesitation.

The mind is lulled into repose and the body obeys the impulse of the mind.

Cadillac thoroughness is responsible for the accuracy of every function which contributes to the efficiency of the engine.

The known stability of the Cadillac inspires a confidence which removes all anxiety for your safety.

The pleasures of today are not marred by apprehensions for tomorrow.

And, too, the spring suspension, the deep soft upholstery, the smooth, easy acting clutch and brakes, the ease of handling and control, all share in resting and soothing mind and body.

With bad roads largely robbed of their terrors, and good roads made almost doubly delightful—with hills no longer to be dreaded—with a sense of velvet softness in every motion of the car and every movement in its operation, there is a renewed and irresistible call to long distance touring which—in the Cadillac—becomes an unalloyed delight.

Cadillac
Standard of the World

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel

KNICKERS, DRAWERS AND THE LIKE FOR FEMALES.—OLGA E. BULEY, 7 Burbage road, Herne Hill, London, England. This invention particularly relates to a method by which the flap is normally held in closed position but which can be moved into the open position without the necessity of unfastening buttons or the like, and consists in providing the flap with a band normally passing around the waist, such band being made so as to be passed downward over the body in order to turn the flap down.

INNER LINER FOR SHOES.—W. KREUZER, care of Wilson, 410 W. 130th St., New York, N. Y. This invention relates to liners for wearing apparel and has for an object the provision of an improved liner which incloses the foot and holds the same from contact with the shoe so as to prevent the transmission or absorption of heat from the foot.

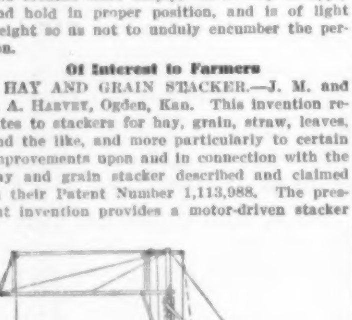
SPINE ARCH SUPPORT.—E. PACKER, care of M. Packer, 2134 Kent St., Los Angeles, Cal. This invention relates to a support for the arch of the spine so as to support the human body from the small of the back to a

SPINE ARCH SUPPORT

point just above the waist line and thereby give support to the curvature of the spine, whereby a person will stand erect with greater ease, walk with more comfort, sit straight and breathe more deeply. It is easy to apply and hold in proper position, and is of light weight so as not to unduly encumber the person.

Of Interest to Farmers

HAY AND GRAIN STACKER.—J. M. and J. A. HARVEY, Ogden, Kan. This invention relates to stackers for hay, grain, straw, leaves, and the like, and more particularly to certain improvements upon and in connection with the hay and grain stacker described and claimed in their Patent Number 1,113,988. The present invention provides a motor-driven stacker



HAY AND GRAIN STACKER.

which deposits with speed and precision, large loads of hay and grain in the straw, at any desired point throughout the entire length, breadth and height of the stack, and the stack may be any length desired as material is deposited alongside of but parallel to the line of travel of the carriage of the machine.

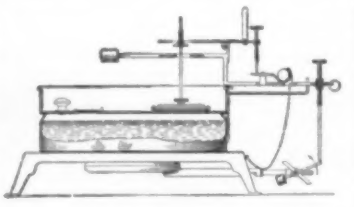
Of General Interest

WATCH BOW MOUNTING.—L. S. HANSON, Eureka, Mont. The improvement provides a watch bow mounting in which the bow has orifices in alignment with each other, and through which pins extend for insertion in recesses at the sides of the watch pendant, the pins being held against removal by frictional engagement with the pendant at the recesses therein.

SEAL.—W. L. KELLY, West 1303 Cleveland Ave., Spokane, Wash. This invention has particular reference to a car or package seal. It provides a device of this character which is preferably made from a single sheet of metal formed into a housing and locking device which, after being locked, cannot be opened without tearing or mutilating the same.

BOTTLE CLOSURE.—J. B. TREVOR, 11 E. 91st St., New York, N. Y. This improvement relates particularly to a bottle closure and provides a construction which positively seals the bottle. It provides a closure formed with sealing material arranged thereon of a pliable nature so as to positively seal a bottle or other receptacle to which it is attached, even though the same may be irregular or rough.

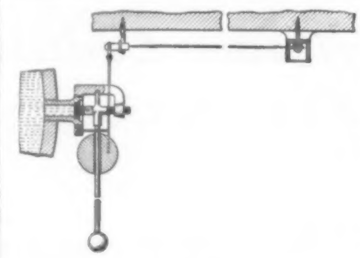
PASTEURIZER.—P. MAICAMP, care of Mr. Charbonnet, druggist, corner of Derbigny and Frenchman Sts., New Orleans, La. The inventor provides a device for use with gas stoves and the like, for pasteurizing milk, wherein mechanism is provided controlled by



PASTEURIZER.

the heat of the milk being pasteurized for cutting off the flow of fuel to the heater when the milk has attained a predetermined temperature. He provides a device which may be used in the same manner to cut off the fuel supply when the milk begins to boil, and controlled by the boiling of the milk.

AUTOMATIC FIRE EXTINGUISHER.—H. W. MEYER, 152 William St., Newark, N. J. This invention relates more particularly to a fire extinguisher provided with a nozzle having a controlling valve and arranged to discharge a stream in a predetermined direction, and means for operating the controlling valve automatically from a remote point in the di-



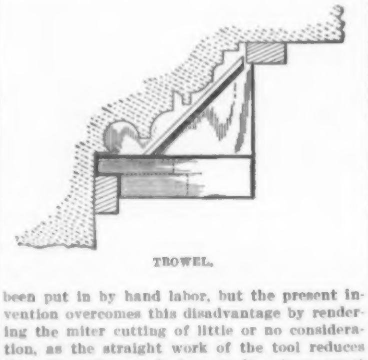
AUTOMATIC FIRE EXTINGUISHER

rection toward which the stream will be discharged from the nozzle. Its invention also relates to the aggregation of a plurality of nozzles. It further relates to an automatic valve which comprises a body constituting a fluid passage for the escape of water and having an outlet, a removable closure for the outlet, and automatic releasable means gravitationally operable to displace the valve outlet closure.

Hardware and Tools

RAZOR STROPPING MACHINE.—R. E. BROWN, care of American Hone Co., Olean, N. Y. This improvement provides means for holding the abrasive materials in a straight path while in contact with the edge of the blade; provides means for accomodating blades of different length and shape; avoids carrying the abrasive members past the cutting edge; and simplifies and cheapens the construction.

TROWEL.—P. L. FERGUSON, 863 Capital Ave., Ogden, Utah. This invention relates to plastering tools, and more particularly to a trowel whereby a suitable design of plaster cornices or moldings may be readily and uniformly made on walls and ceilings of rooms. Heretofore, miters of plaster cornices have



TROWEL.

been put in by hand labor, but the present invention overcomes this disadvantage by rendering the miter cutting of little or no consideration, as the straight work of the tool reduces the price of run plaster cornices to a great extent, making it possible to compete with the stucco plaster cornices of to-day.

TAPPING DEVICE.—E. PEREMI, 329 Union St., Brooklyn, New York, N. Y. The invention relates to hand tools and provides a tapping device for the use of mechanics. It can be readily carried in the hand by an operator for conveniently and quickly tapping a hole and running the tap out of the tapped hole. The compact form of the device permits its use in places where wrenches and like tools employed for turning a tap cannot well be used.

GREASE GUN.—C. H. KIRKENDALL, 127 Duane St., New York, N. Y. This invention provides a grease gun the plunger of which can be driven totally into the barrel without ejecting the contents thereof, if so desired. It provides a grease gun the length of which can always be maintained at its minimum, whether the gun is full or not.

Heating and Lighting

GAS FIRE STARTER.—H. CARDIN, 390 Chester St., Brooklyn, New York, N. Y. This invention provides an attachment whereby ordinary illuminating gas may be conveyed to and utilized in a fire box for starting the fire in which heavy fuel such as blocks of wood, coal or the like is employed, the device being designed especially for self-support upon one of the grate bars of any usual or ordinary construction.

Household Utilities

FOLDING CHAIR.—J. D. LAWRENCE, 200 Nassau St., Princeton, N. J. This invention refers to folding chairs or stools. It provides a design for the manufacture of a chair mainly from tubular metal whereby it will be not only cheaper but stronger than the usual forms of folding chairs. It provides facilities for renewing the fabric seat portion of the folding chair and at the same time prolonging the life of said seat.

SINK COVER.—S. A. GODOY. Address W. Hunt Harris, Attorney, Key West, Fla. The cover is for use with open sinks, closets or vaults, wherein a perforate cover and a seat are provided, connected together and mounted to swing into and out of operative position, and wherein a swinging platform is arranged at the front of the sink, and connected to the seat and cover in such manner that when the user steps upon the platform the cover will swing out of position and the seat will be swung into position, while when the user steps off the platform the seat will move out of operative position and the cover will move into such position.

FLY TRAP.—J. F. OLLER, Delray, Fla. The trap is for use in catching the fly known as the "grape leaf hopper," or black fly, that is so destructive of the bean industry in Southern States, and the invention provides a device mounted to be drawn through the field and having means for causing the flies to arise from the ground and the plants, and having means for catching the flies as they arise.

Machines and Mechanical Devices

LABELING MACHINE.—G. W. MCCULLEY and G. L. MASON. Address the former, Valdosta, Ga. This invention is especially adapted for labeling cans, as, for instance, cans containing preserved meats, fruits, and the like, wherein a hand or power operated machine is provided, having gravity operated mechanism for feeding the cans in succession to the machine, and wherein mechanism is provided in connection with the feeding mechanism for delivering the cans one by one to the labeling mechanism, and wherein the labeling mechanism is arranged to apply the labels to the cans as they pass by the said mechanism.

PAN CLEANING MACHINE.—T. H. KELLER, 24 No. Shipper St., Lancaster, Pa. This improvement refers to a machine for cleaning and greasing pans, such as are used by bakers for baking bread. The machine is intended for removing the crust and burnt particles which adhere to the pans, and to scour and grease them preparatory to further baking operations.

CALCULATING MACHINE.—A. W. CAMPBELL, 76 Clinton Ave., Clifton, N. J. This invention provides a calculating machine more especially designed as an aid in making up pay-rolls to enable the cashier or other persons to accurately and quickly determine the number of bills and coins of different denominations required in paying off the employees.

PNEUMATIC PILE FEEDER.—G. BRANDSTETTER and R. FREUND, Hohenstadt, Moravia, and Vienna, Austria-Hungary. This invention relates to automatic pile feeders for printing presses. It avoids the various deficiencies met with in apparatus of this class as heretofore constructed. An advantage is in the provision of an apparatus which may be simply and readily mounted in position, and which is independent of the construction of the press, and which can be operated by small pumps running at a higher speed than the press.

SHEET REGISTERING CONVEYER.—A. B. ANDERSON, Nanuet, New York, N. Y. This invention relates to sheet conveyers for box making machines, presses, folders, and the like, and has to deal more particularly with means for automatically causing the sheets to be automatically registered or uniformly fed into the machine with which the conveyer is used.

TRANSMISSION MECHANISM.—S. P. WHITESIDE, Box 585, Baltimore, Md. This invention relates to transmission mechanisms, having a variable speed control which transmit more power than could be transmitted through the variable speed control directly. The transmission mechanism is characterized by a positive drive and a friction drive associated therewith and controlling the variable speed of the transmission mechanism—that is, of the positive drive.

CLUTCH.—S. P. WHITESIDE, Box 585, Baltimore, Md. The invention relates to clutches whereby a driving and a driven member can be first slipably connected, to bring the two members to substantially the same speed, then positively coupled. It provides a transmission clutch whereby a driving and a driven member can be positively coupled without danger of injury to the parts of the clutch mechanism.

WRAPPING MACHINE.—A. LINKER, 970 Eastern Parkway, Brooklyn, New York, N. Y. This invention relates to wrapping machines, and particularly to machines designed to sever a bar or other supply into sections and then wrap the sections. It provides a wrapping machine which will fold a wrapper around an article and then fold the ends of the wrapper.

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The Difficulties of Railroad Maintenance in Alaska

(*Concluded from page 523*)

a few hours before the entire mass of falsework disappeared in the grinding break-up of the ice. Concrete ice-breakers have thus far sufficed to keep the river ice from carrying out the slender piers, so that neither glacier has advanced to menace the bridge.

A few miles above the bridge, the moraine of the largest glacier, the Miles, dams up the river, forming a natural reservoir in the gorge for 20 miles above the obstruction. The line is obliged to follow for that distance the shoreline of this body of water, after which the gorge becomes so narrow that sidehill construction is necessary. At mile 130, Chitina, the first town on the line is reached. The Copper River is here crossed on a pile trestle nearly a mile in length, and the Chitina River is followed to the terminus of the line.

Operation of the line is maintained throughout the year, with a usual schedule of a train a day each way. Operation is probably the most regular in winter. In summer the story is very different. In August of last year, when the pictures illustrating this article were taken, operation between termini was suspended at one time for over two weeks, and at other times for a shorter interval. The water rose 10 feet above all previous marks, and covered the rails for 20 miles above the obstruction. The furious currents of the glacial tributaries took out many trestles, and the whirlpools of the main river, as appeared when the water subsided, had in several places turned the heavy track completely over, as if it had been but a strip of canvas. While the lower parts of the line had been under water, forest fires caused by the intense heat were raging along the last hundred miles. We found several trestles, one of them ninety feet high, and a thousand feet long, ruined. The fire, where it did not destroy the timbers entirely, ate out the joints, and rendered the structure useless. A few hours after we left Kennecott on our return, the lake which each summer forms within the glacier, burst, and took out with it 18 bents from the trestle across the stream at the foot of the glacier. Later on the return journey we rode on new track around a heavy landslide caused by the thawing of frozen ground on the mountain-side. Parts of the trestle bridges across the main river are taken out each spring by the ice, and owing to the fury of the current watch must be kept over them every hour in the year.

Acknowledgement should be made of the remarkable efficiency shown in the operation of the road. Considering the difficulties involved, delay to traffic is very small, and wrecks are almost unknown. The road is now operated at a profit, and a short extension will open up the Bering River coal fields, and the petroleum deposits of the Katalla region. Over a million dollars worth of copper ore is shipped each month over the road, and thousands of cases of salmon each summer. Passengers are transported at a rate of 12 cents per mile.

The Size of Naval Guns

(*Concluded from page 530*)

accuracy and penetrative power, considerably greater than that of a salvo of eight 17-inch shells.

The direct penetrative power of armor-piercing projectiles against homogeneous nickel-steel armor is usually computed by means of what is known as the de Marre formula, which is:

$$V = K \frac{d^{.75} e^{.7}}{p^{.5}},$$

where V is the striking velocity of the projectile, p its weight, d its diameter, e the thickness of armor penetrated, and K a constant. The same formula is used in the case of face hardened armor by assigning a "figure of merit" of 1.5, or by taking the required velocity 1.5 times as great as that given by the formula. The velocities of 14-inch and 17-inch projectiles must then be, for piercing the same plate, in the ratio:

$$V_{14} : V_{17} = \frac{d_{14}^{.75}}{p_{14}^{.5}} : \frac{d_{17}^{.75}}{p_{17}^{.5}}$$

or

$$V_{14} : V_{17} = 1.154 : 1,$$

the smaller shell requiring 15 per cent more striking velocity than the larger.

Furthermore, the larger projectile holds its velocity longer during flight, since, by Mayevski's differential equation for the retardation caused by the air:

$$\frac{dv}{dt} = -A \frac{d^2}{p} v^n.$$

Therefore, if the two projectiles leave with the same velocity the lighter will at once begin to lose velocity faster than the heavier by the ratio:

$$a_{14} : a_{17} = \frac{d_{14}^2}{p_{14}} : \frac{d_{17}^2}{p_{17}},$$

or

$$a_{14} : a_{17} = 1.211 : 1.$$

Thus, if the two guns have the same muzzle velocity the 17-inch projectile will arrive at its target with the higher velocity, and conversely, if the 14-inch will just penetrate a certain thickness of armor at, say, 15,000 yards, the 17-inch should be able to penetrate the same armor at a much greater range.

It appears from the above that at very great ranges the 14-inch shells will not be effective except against the upper works of a ship, and that armor will turn them aside much more readily than it will the 17-inch; at smaller ranges, however, the greater number of light shells will have a greater effect than the smaller number of heavy projectiles. This deduction accords exactly with the observed facts.

Certain inaccuracies are inherent in the flight of projectiles and in the aim of naval guns. The inaccuracies of flight may be laid to such things as small differences in the weights of the projectile and the powder charge, more or less unsteady flight due to the fact that the center of gravity of the shell may not lie exactly in its axis of rotation, slight differences in the action of the powder upon firing, different wear in different guns, and many other small causes. The total effect of all the inaccuracies is an error whose average is nearly the same for all large guns, if the angle of fall is the same. Therefore, if the 14-inch and the 17-inch shell have the same angle of fall it is to be expected that we will get 50 per cent more hits with a twelve-gun battery than with an eight-gun battery.

As the range increases the angle of fall of the 14-inch increases much more rapidly than the 17-inch, since the latter keeps its velocity longer. There will be a certain range, therefore, when the probabilities of hitting, which depend upon the errors and thus upon the angle of fall, will be exactly the same for the 14-inch 12-gun battery as for the 17-inch 8-gun battery. The larger shells would now, with an equal number of hits, be much more effective, since their penetrative power is so greatly superior. There is also a certain range, less than the range where the chances of hitting are equal, where the destructiveness of the two batteries would, in the long run, be exactly equal. If we expect to fight our naval battles at ranges less than this certain range the battery of twelve small guns is to be preferred to that of eight large guns, while if we expect to fight our battles, *as a rule*, at greater ranges, the large guns will be the more effective.

Naval guns do not fire at a target at sea under the same conditions as do emplaced guns. The latter may be aimed by laying them at vertical and horizontal angular distances from some fixed reference point, and when fired will send their projectiles to a certain definite point on the earth's surface, neglecting errors. Naval guns, on the contrary, must, due to the vessel's motion, be aimed by a man some place on board the vessel itself, who must be able to see some part of the target at which he is firing. Under the present system of spotting the fall of

shot the spotter is on a platform about 125 feet above the surface of the water, and he must be able to see the waterline of his target. Thus the utmost possible range at which naval fighting may be carried on is limited by the horizon of the eye of a man about 125 feet above the water. The distance of this horizon is 25,800 yards, so that about 25,000 yards may be considered the greatest possible range for vessels firing under present conditions.

If the existence of a critical range for two batteries, such as that defined above, be admitted, then very evidently there must be some certain battery of guns of a certain size, which will be more effective at ranges up to 25,000 yards than any smaller number of larger guns. There will thus be no advantage in going to a larger gun, but on the contrary a positive disadvantage, since at such ranges as have obtained in the present war the disproportion will be even greater. And unless we can be sure of having a faster and more mobile fleet than an enemy armed with even smaller but more numerous guns we can not be sure that he will not close in and defeat us at comparatively short ranges.

The limit of *effective* range for a battery, from what has been said, is seen to be that range at which enough hits may be scored to sink the enemy ship before the ammunition is exhausted. The striking velocity of the projectiles must be sufficient to penetrate the armor protecting the vitals of the ship at that range. Ordinarily this must be considered to be the side armor, since the protective deck armor may only be penetrated by a plunging, or nearly vertical, fire, and hits of this character are chance hits. It will be interesting to compare, roughly, the relative effectiveness of the 14-inch and 17-inch batteries we have discussed, at the range limit of 25,000 yards, and to find the weak and the strong points of each.

A 14-inch shell leaving the gun with an initial velocity of 2,800 feet per second will arrive at a target 25,000 yards away with a remaining velocity of 1,373 feet per second, and will fall at an angle of 26°-13' with the horizontal plane. The danger space for the side of a ship 30 feet high will be 19.5 yards, and for the whole ship, if her beam is 90 feet, 49.5 yards. The striking velocity will take the shell, in the majority of cases, through 10.6 inches of armor, using a "figure of merit" of 1.5 in the de Marre equation.

A 17-inch shell, on the other hand, with an initial velocity of 2,800 feet per second, will strike 25,000 yards away with a velocity of 1,478 feet per second, which is sufficient to carry it through 12.2 inches of armor. The angle of fall will be 22°-14', and the danger space for the 30-foot side of the ship will be 24 yards and for the whole ship 54 yards.

If the errors in the range vary directly with the angle of fall, which is a rough approximation, a 14-inch shell would have 84 per cent as good a chance of hitting as a 17-inch if the danger space were the same. But since the former has a danger space of 49.5 and the latter 54 yards, the 84 per cent must be reduced (again approximating) by the ratio of 49.5 to 54. This gives 77 per cent for the 14-inch. But since there are twelve 14-inch and only eight 17-inch, we might actually expect 1.16 hits of the former to one of the latter.

It is immediately apparent that the 17-inch battery has a marked advantage over the 14-inch at a 25,000 yard range, since the latter will very seldom penetrate the protective armor, and its advantage of 16 per cent more hits is lost because so few would be effective.

It is not until the range has dropped to 18,500 yards that the 14-inch will be able to penetrate 12.2 inches of armor, and since armor protection of at least 12 inches will ordinarily be encountered on heavily armored ships the limit of range at which the 14-inch will be effective must be considered to be between 18,000 and 20,000 yards. And it must also be admitted that, owing to the increased probabilities of hitting at such a range, the twelve 14-inch guns will be more ef-

fective than the eight 17-inch guns at less than about 18,000 yards.

In the calculations above it has been assumed that the larger gun will have the same muzzle velocity as the smaller. Such an assumption, however, may be found to be false when the work of designing the larger gun is undertaken. As a general rule large calibers do not have as great a muzzle velocity as small, because of the great influence the bore pressures and powder chamber volumes, and thus velocity, have upon the life of guns. If we are content to have our guns wear out quickly we can have a high velocity, but if we consider it important to have a gun that will last through many engagements the matter must be more carefully considered. Then if the large gun is assigned a lower muzzle velocity than the small gun, the advantage of the 17-inch gun at ranges in excess of 20,000 yards may nearly, if not quite, disappear. In that case an even larger gun would have to be mounted to be effective at 25,000 yards.

The "life" of a gun is measured by the number of rounds it will shoot accurately. After a certain number of fires, which is practically constant for all guns of a certain type, the flight of the projectile will be erratic. The gun must then be withdrawn from service. The principal reason for this wear is the eroding action of the heated powder gases flowing over the metal of the bore, and to make the gun serviceable again it must be re-lined. In large calibers the walls of the gun will conduct away less heat proportionately than in small calibers, and thus the eroding action of the gases is much greater in the former. The life of an infantryman's rifle, for instance, is several thousand rounds, while the life of a large naval gun is only a few hundred rounds. If the muzzle velocity, and thus the powder pressure and temperature of combustion, is lowered, the erosion of the bore will be smaller. So there is always an excellent reason for hesitating to adopt a larger gun with a very high velocity, particularly since the life can not be always accurately predicted.

Few of the elements that have been here considered are mathematical, and most of them must be judged according to the ideas of experienced men. One artillerist, for instance, may hold that a shower of light shells will be best, since it will quickly disable an enemy through putting his guns out of action; another may believe that it is best to attempt to sink the ship by shells penetrating the armor and exploding inside. Others base arguments for or against larger calibers on the single premise: better speed than the opponent. The first of these would use speed to stay out of the enemy's range and, with heavier guns, slowly sink his vessels; the second would rather have many light guns and by using superior speed close with the enemy until his heavier guns were at a disadvantage. If we could have as many heavy, high-powered guns and with as long a life, there would be no question of choosing lighter guns. But if we reduce the muzzle velocity considerably, and have fewer of the heavier type, careful and deliberate judgment must be exercised to determine upon which side the balance inclines.

Modernizing Mississippi River Transportation

(*Concluded from page* 531)

In the matter of appliances for protecting the boat against accident the Mississippi steel barge is unusually complete. The protective measures adopted for the hull have already been discussed. The vessel carries 2,000-pound anchors at bow and stern, and by the aid of powerful electric winches these can be used to haul the boat off if she runs aground. A gun which can shoot a line 1,750 feet, in design not unlike those employed in the life-saving service, is also provided. The barge carries two small boats: one, a 20-foot launch capable of 22 miles per hour speed, which, by means of the traveling crane, can be lowered into the water in two minutes' time; the other, a rowboat of conventional type.

The barge is equipped with a powerful wireless telegraph set that permits of communication at any time with the offices in St. Louis and New Orleans. The aerial for the wireless installation is elevated on two telescopic masts which can be lowered when passing under bridges. The wireless installation is not intended to serve merely as a means of summoning assistance in case of disaster: it plays an important rôle in the everyday work of the barge, namely, to enable the captain to report regularly to the offices regarding his position, speed, the weather, etc., as well as keep the accounting department informed as to the freight on board the boat before its arrival. It is also possible by this means to make the necessary arrangements with the roustabouts at the next landing place, so that the minimum of time will be consumed in the unloading operations.

The electrical equipment of the vessel is elaborate. Current is supplied by an electric generator driven by a silent chain from one of the engines. When the boat is not in motion a clutch on the propeller shaft is thrown out and the engine continues to drive the generator without turning the propeller. Aside from furnishing current for the lights and the three powerful searchlights—one at the bow, one at the pilot house and one at the stern, each controlled from the pilot house and representing a combined candlepower of 18,000, the generator supplies power for the dozen or more motors that are used for different purposes on board. Current is also used for all the heating and cooking on the barge, since no fire is allowed on board.

A Pen that Permits of Writing with the Mouth

(*Concluded from page 533*)

one half of the crowns of the lower teeth, whereas the upper ones only rest on it with their lingual surfaces, thus leaving the edges and labial surfaces disengaged. In fact, the mouth-piece remains fixed to the lower teeth, even when the mouth is open.

A straight and rigid penholder obviously would have been inconvenient, besides straining the muscles of the neck and jaws. Mr. Grünberg therefore designed a penholder comprising three joints, one of which—the central one—was fitted with a spring endowing it with sufficient elasticity. The penholder is made up of two tubes sliding inside one another, their total length being adjusted by means of a set-screw. The nib is preferably one with rounded or ball point and can be replaced by a pencil at a moment's notice The paper is kept in position by a rectangular brass ruler covering its left-hand and upper edges.

Systematic training was, of course, required to acquaint the man with the use of this arrangement: beginning by simple dashes, he proceeded to the tracing of separate letters and words. After getting through about half a dozen copy books as used in schools, he was able to write with the utmost ease and as readably as few of his class with their right hands.

War Game—X

(*Concluded from page 532*)

fullest fire effect and still hides the barbed wire from the eyes of the approaching enemy, is a very effective arrangement. The entanglements are placed at a distance which permits the fullest use of the rapid fire rifle. Entanglements with mechanical devices enabling the defenders to pull them up into shape just in time have proven of great value in defensive warfare.

Once the belligerents have settled down to trench war, the simple trenches are improved and many other means are employed to strengthen the defensive lines in addition to the barbed wire entanglements. These means vary a great deal, but in principle they are similar to those used in the preparation of regular fortifications, They include ditches, abattis—built up of trees with the branches left on and sharpened, wood or iron "fraises," "trous-de-loup" holes with spikes in them and every imaginable device which will create an effective obstacle. But of them

all, a good barbed wire entanglement is by far the best.

The effect of these obstacles is very great, especially if the attacking party should encounter them unexpectedly. The assaulting force is brought to a standstill at close range, perfectly exposed. That this means tremendous losses is quite evident.

Now we can consider the effect of artillery fire upon these defensive preparations and how to guard against this artillery fire.

Trenches with a perpendicular wall and of sufficient depth will offer excellent protection against projectiles flying horizontally, such as rifle and machine gun bullets. When a searching fire of shell or shrapnel is considered, these same trenches will be found lacking in protection.

The shrapnel is a cleverly arranged miniature gun in itself. This is fired at a range of several miles, and bursts, if well timed, about 30 feet above and from 20 to 75 yards in front of the target, scattering at its burst about 250 bullets over the surrounding ground. The angle of fall is such that many of these bullets will find their way into the trenches. To protect the men in the trenches from this fire overhead cover must be provided. This cover is formed by placing beams and logs over a portion of the trench and covering with sufficient thickness of earth to stop the projectiles. As a matter of course, these shelters must be made as invisible as possible, so that they may blend with the surrounding landscape and resist the searching eye of the artillery observer.

We shall not go into details regarding howitzers just now, for our present problem will not deal with heavy calibre guns.

There are two chances to work on trenches under fire. The simpler one is during the night under cover of the darkness. The second is to work under cover of heavy fire by supporting troops, directed on the enemy lines to hold the fire down or to render it less effective.

All these defensive preparations lead to no decision, and since every moment lost while at a standstill is a waste from a strategical standpoint, it is evident that trench warfare is a very expensive undertaking.

The Means of Reaching a Decision in Trench War

Once two forces, under conditions given in the last War Game and this present Game, have settled down to the modern trench war, there will be a singular situation established, which will appear entirely different from the field operations so far considered. To achieve success, one side or the other must make an advance. This must be done by slow stages. Should there be a distance of 1,000 yards between the opposing first line trenches, the approach can be made by constructing zigzag trenches in the direction of the enemy, exactly like a siege operation. At intervals branches are laid out as regular firing trenches, approaching closer and closer to the enemy, and thus constituting what is termed a parallel.

There is also the method which the Japanese introduced: Men carrying steel shields rush out of the firing trenches and start a new trench in front of the firing line. As soon as shelter is made, other men rush out and occupy it and strengthen the new line. This work is done under cover of the fire of the infantry and artillery.

These processes continue until the trenches are so close together that this sort of operation becomes impossible.

When our Red and Blue trenches have approached to within one hundred yards of each other, a new phase of the fighting must be considered. The chief arm for the defense is now the machine gun, while the attackers rely upon the bayonet, the butt of the rifle and the hand grenade.

Night attacks, which are very rare in open field fighting, are commonly used in trench warfare. In operations of this latter sort the occupants of one trench know exactly where the enemy is located,

and there is therefore no danger of mistaking their own troops for those of the enemy. For this reason these night attacks will be frequent. Since the tactics of trench war are too new to have their own book of instructions or regulations, we may give our own names to the three different attacks now in use: The small surprise attack, the larger prepared attack and the mine attack.

The first is self-explanatory. The second means that by concentration of heavy artillery fire on a selected section the defenses are either breached or destroyed, and the defenders are either killed, driven out or too badly demoralized for an effective resistance. That section is then stormed by as large a force of infantry as can be massed for that purpose. As soon as the assault is successful, the artillery and the infantry, which have assisted the assault by their position fire, will shift their fire to establish a curtain of fire in front of the assaulting line, to enable them to hold the newly won positions. Connecting trenches are constructed with the greatest possible speed. When this is done, the trenches of the new position can be considered as consolidated, because from this time, reserves, ammunition, food, etc., can be brought up to the new line.

Every such advance, however, will expose the flanks of the advanced trenches to the enemy fire, and for this reason it is very difficult to hold such positions.

The mine attack is a feat in military engineering. It is very simple and at the same time difficult and dangerous to carry out, both for the underground workers and the attacking party on the surface.

A land mine is a mass of buried explosive, sufficient when exploded to blow up a considerable tract of ground with everything on it. The aim of the engineers, the sappers, is to place such a mine under the enemy trenches, and then blow it up. This necessitates the digging and timbering of a narrow tunnel straight to the enemy trenches. When the proper distance has been reached, a mine chamber is built, the mine is placed, the sap head is banked tight with bags of earth backed up and reinforced with timbers, to be sure that the force of the explosion will be directed upward and not back through the tunnel. The mine is then ready to be exploded by the prearranged electric wiring and spark device. When the time for the mine attack has arrived the soldiers who are to form the attacking party are in readiness in the firing trench. The engineer officer presses the button and a section of the enemy trench is thrown into the air. The waiting attackers charge and occupy the crater.

The consolidation and holding of the crater is entirely dependent upon the assistance given by the artillery.

The accompanying sketches will explain this method of modern fighting.

Developments and Situation

At 3:30 P.M. the Blue forces, after severe losses, established themselves in the cemetery east of Pottstown. Thereupon Brigadier General LG ordered a general advance against the small woods at the fork of the roads. To accomplish this, he ordered forward the main infantry reserves from their position on the western edge of the forest. The cavalry was brought up to a position in readiness on the Eden-Norrisville road.

At 3:50 P.M. the forward movement reached the line of the railroad and the advanced trenches of the Reds. At this point they came under heavy fire from the Red battery in position near Pottstown and had to take severe losses. This fire, combined with that of the Red infantry, forced the Blues to entrench.

The Blue cavalry was brought back into the cover of Paoly Forest.

At 3:40 P.M. General G of the Red forces received orders from his headquarters to remain on the defensive.

By nightfall the Red and Blue forces had entrenched about 600 yards apart.

Questions

Question 1. What sort of an order will Captain B give to his company after he has approached to within 200 yards of the cemetery and is ready to assault the Red platoon holding the position?

Question 2. Having driven the enemy from the cemetery, what will happen? Will Captain B issue an order?

Question 3. General G follows the development of the combat from the tower of the City Hall. He sees heavy Blue reserves debouching from Paoly Forest. What will be his decision? How will he put his order into execution?

Question 4. The Blue detachment has a machine gun platoon. Where could the best use be made of them?

Question 5. Issue an order to establish the Blue entrenchments. This order is to be issued at 9:00 P.M.

Answers to Questions in War Game IX

Question 1. The range is exactly three miles. This would mean exactly 5,280 yards, which is a distant range for the Goat Hill battery. The other battery on Hill 50 is slightly over two miles from Ash Inn. The distance, being 3,700 yards, is well within effective range. See the batteries on the map.

Question 2. See map.

Question 3. The order given by the Blue advance guard commander will be as follows:

We will attack the enemy's position in our front.
The First Battalion will be the firing line and will advance in the direction of the small patch of woods.
The Second Battalion will be the support and will follow behind the center of the firing line.
I will be with the support.

Question 4. As soon as the Red artillery observes the enemy on the edge of the forest, shrapnel fire will be directed against them. Knowing the exact range, this fire ought to be very effective. Also, the infantry will open fire whenever good targets offer themselves. The range is about 1,200 yards.

Question 5. The squadron has returned to Pottstown via the railroad bridge. It will be held in readiness with the reserves.

Question 6. The squadron was fired upon by enemy patrols which were at that time in Paoly Forest.

Question 7. The omission of the question of communication with the Red division in the north is an error. It was also an error in a former order in the VIII War Game. But if the highest commander omits to provide for communication in his order, the subordinate commander who commands the element of the left flank of the line must send out a left flank patrol, which would establish the connection automatically.

The next War Game will deal with the defense against an enemy landing party.

Industrial Preparedness for Peace

(*Concluded from page 526*)

Results Obtained

When the standards in the Calendering Department were established, the average efficiency was about 62.0 per cent. This efficiency gradually climbed to 100 per cent, and after a period of three years had reached 110 per cent. When our standards were exceeded by 10 per cent, it meant that our allowances for delays, etc., were more than ample, and the creation of habits of efficiency permitted the men to attain excessive efficiencies.

Table Showing Total Output of Coated Calendering Dept. (for 1 yr.) for Varying Efficiencies with Varying Costs

Efficiency	Output (lbs.)	Labor Costs, including Bonus	Burden	Total Cost	Cost per lb. (in cts.), inc. Bonus	
					Labor	Total
63	31,800,000	$33,950	$55,200	$89,150	.107	.280
66 2/3	33,800,000	33,950	55,200	89,150	.100	.264
80	40,500,000	35,200	55,200	90,400	.087	.223
90	45,500,000	37,300	55,200	92,500	.082	.203
100	50,600,000	40,700	55,200	95,900	.080	.190

What did this mean to the paper manufacturer? It meant an increase of 80 per cent to 90 per cent increase in production per labor unit, at the same over-head cost per day, or a corresponding reduced cost per unit of output. It meant an aggregate annual saving of $23,000 under 80 per cent efficiency, or of $45,500 under 100 per cent efficiency. What did it mean to the worker? It meant better material, better machines, better maintenance, and an average increase in wage of 30 per cent. These conditions permitted the manufacturer to manufacture a better paper at the same price, or the same paper at a reduced price, and thereby meet competition with a distinct advantage. That is Industrial Preparedness for Peace.

NEW BOOKS, ETC.

The Principles of Health Control. By Francis M. Walters, A.M. New York: D. C. Heath & Co., 1916. 8vo.; 476 pp.; illustrated.

Unusually good is this textbook on physiology and hygiene; it has an unique and striking arrangement of material, based upon the different sources of health control. We learn of this control through exercise and posture, through adjustment in foods and the avoidance of harmful substances, through elimination, through nervous conservation, and through the mind; finally the defensive and offensive methods of germ fighting are set forth, and the part that environment, the physician, and the law plays or should play in the evolution of individual and national well-being. Much emphasis is laid upon corrective measures, since modern life is merciless to the man who ignores such measures. Interesting diagrams, illustrations, and tables abound throughout the work; each phase of the subject has been placed upon the basis of cause and effect, and guesswork has been largely eliminated.

"James Norris." By Albert Pyrmont. New York: C. Regenhardt, 1915. 8vo.; 560 pp.

The story of this novel is a chapter from the Arabian Nights, modernized, but unexpurgated. Between the acts proper are interpolated reams of semi-serious discussion in which the warring nations are regulated, law is revolutionized, sex is expounded, health is preached, and the Scriptures are reconstituted. Much of this reasoning runs in shallow water; some is channeled through rock; at times it is Shavian in its paradox. With all the faults of a first work, and with not a few peculiarly his own, the author shows marvellous scope and amazing industry. Most readers will attain the end, albeit by a skipping process which the author himself suggests.

The Wireless Telegraphist's Pocket Book. Of Notes, Formulae and Calculations. By J. A. Fleming, M.A., D.Sc., F.R.S. London: The Wireless Press, Limited. 12mo.; 347 pp.; illustrated. Price, 6s. net.

In the practical calculations connected with radiotelegraphy, a handy compilation of formulas and tables is more than a mere convenience; it is a necessity. Such a compilation is the manual put out by Dr. Fleming, of the University of London, who already has to his credit numerous works on electrical subjects. His first chapter refreshes the memory of the student or operator with just that mathematical information which furnishes the working tools. Most of the succeeding data is based only upon arithmetical principles, but the final chapter provides logarithms and trigonometrical tables, and tables of squares, cubes, square roots and cube roots. While some few pieces of apparatus are pictured and briefly described, for the most part the book leaves this kind of instruction to the treatises, and concentrates its effort and its limited space upon the most useful and important data called for in connection with alternating high frequency currents and radiotelegraphic work. Its convenient form, its accuracy, and its practical offerings should make it popular with the craft.

Industrial Organization and Management. By Hugo Diemer, B.A., M.E. Chicago: LaSalle Extension University, 1915. 8vo.; 291 pp.; illustrated. Price, $2.

Here is summarized and illustrated those principles which have come to be recognized as the essential elements of the new industrial efficiency, from the broad fundamentals of sound organization, satisfactory location, and well-planned buildings and equipment, to actual operation in all its branches—buying, receiving and storage of materials, the planning of finances, sales, production, work, and employment, cost determination, distribution of expense, and standardization. The subject of scientific management is then taken up; time and motion studies and wage systems are considered, and employment problems are solved. Diagrams and charts are displayed in profusion; the very latest methods of motion study, such as that which photographs the movements of an electric light attached to the hand of the workman, are explained; in short, the volume is a complete exposition of the latest practice, methods, and devices used to increase both quality and quantity of output while at the same time improving working conditions for the individual. The author is a well-known consulting engineer, not a mere theorist, and his interpretation of the new movement, with his concrete examples and his arguments based upon actual achievements is extremely clear and commendable.

New Lubricant resists heat-prevents rapid formation of solid matter in your crank case

High temperatures in your automobile engine turn a large part of ordinary oil into black solid matter—your car's greatest enemy. This new lubricant prevents rapid sedimentation, protects metal surfaces, reduces expense

Ordinary oils break down under the terrific heat of an automobile engine after a few hours' use. A large part of the oil forms black sediment.

The sediment is destroyed oil—heat has killed all lubricating value in it.

This solid matter in your oil means wear in your engine.

The polished surfaces of bearings and cylinder walls appear smooth to the naked eye, but a magnifying glass will show you that even the finest surfaces are rough and consist of sharp points and depressions.

When the microscopic teeth of these surfaces are rubbed together they are broken off—worn down. The thin film of oil which forms a nearly frictionless cushion between metal surfaces — such as in the bearings, or between cylinder walls and pistons—is all that prevents your motor from seizing and destruction. As long as the film of oil thoroughly covers the metal-to-metal surfaces, the motor will run without excessive wear, but as soon as the oil is turned into solid matter the microscopic teeth begin to grind, and friction, the greatest enemy of your engine, does its deadly work.

This shows that metal surfaces although apparently smooth are really composed of many thousand minute teeth. Solid matter in your oil means wear; it partially crowds out the liquid and allows over six hundred square inches of metal surfaces to grind together.

How Solid Matter Damages Your Car

The black solid matter formed by ordinary oils prevents the liquid from reaching the friction points where it is needed. This does not mean that the sediment clogs the pumps or pipes, although that trouble may occur. It means that the sediment which is inactive or negative partially crowds out the remaining liquid oil. This under-supply of oil causes friction—heat—seizing—wear—loss of power and expensive repairs.

Automobile engineers state that from 50% to 75% of repairs and fully 50% of depreciation are due to improper lubrication.

Relative Oil Destruction

The contents of the two bottles shown illustrate clearly the relative durability of ordinary oil and of Veedol, the new lubricant that resists heat. Veedol deposits only a small fraction as much sediment as ordinary oil.

ORDINARY OIL AFTER USE — VEEDOL AFTER USE

Showing Finely Divided Solid Matter in Suspension

Ordinary oils are unstable and therefore unserviceable because of non-heat-resisting chemical structure.

Special processes of manufacture developed by this company and the use of Pennsylvania paraffine-base crude oil give Veedol, the new lubricant, its unusual chemical structure, and its remarkable heat-resisting ability.

Make This Road Test

Remove the drain plug from the lowest part of your motor crank case and allow all old oil to run out. Replace the plug, fill the sump up to correct oil level with kerosene and run the motor slowly under its own power for about thirty seconds, to cleanse the interior. Then draw out all kerosene, replace the drain plug and refill with Veedol.

The exact amount of fuel and oil in the car should be recorded and a reading of the speedometer taken before starting. Then let a test be run over a familiar road, including steep hills and straight level stretches, for any distance up to five hundred miles or more.

You will find that your motor has acquired new pickup and hill-climbing ability, due to the maximum mechanical efficiency made possible through Veedol.

You will find your mileage on both gasoline and oil increases. You will reduce your carbon trouble. Your motor will have more power.

What It Means In Actual Saving

The average mileage of all cars is conceded to be 6000 miles per year and the annual cost of operating the typical or average car is estimated by an expert statistician to be about $416 per year. Depreciation, repairs and gasoline come to about $268.

Solid matter in your oil means friction and wear; friction and wear mean expense; expense varies in direct proportion to the amount of black solid matter formed by the oil.

Veedol prevents rapid sedimentation and saves you real money on these items of expense. The records of taxi-cab companies, bus lines and large corporations that use cost accounting show that Veedol should save you from $50 to $115 per year on gasoline, repairs and depreciation. In addition to these savings your lubrication bill itself will actually be smaller.

If you are interested in saving money you will be interested in making your own tests of this remarkable new lubricant.

Where You Can Buy Veedol

Progressive dealers everywhere have secured Veedol and can supply you. Look for the orange and black Veedol sign. If, for any reason, you cannot get Veedol at once write direct to the Platt & Washburn Refining Company. By return mail you will receive a copy of the book, free, and the name of the dealer who will supply you.

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NEW 88 PAGE VEEDOL BOOK FREE

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Veedol is supplied in one-half gallon, one gallon and five gallon sealed cans; 15 gallon, 28 gallon and 53 gallon steel drums; and in 28 gallon and 50 gallon white oak barrels. A special pouring device is supplied with each metal container. Guaranteed when sold in the original package.